NORMAL ELECTIVE COURSES

IN COMMON SCHOOL AND HIGH SCHOOL BRANCHES

BY CORRESPONDENCE

EDITED BY

W. F. ROCHELEAU

NORMAL DEPARTMENT
INTERSTATE SCHOOL OF CORRESPONDENCE

Formerly State Institute Conductor in Minnesota; later, Teacher of Psychology and Director of the Training School, Southern Illinois State Normal University

Instruction Book Three

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TO THE STUDENT.

"Accustom yourself to reflect on the words you use, hear or read, their birth, derivation and history. For if words are not things, they are living powers by which the things of most importance to mankind are actuated, combined and harmonized." —*Coleridge.*

An eminent educator has said that while other branches are important, a knowledge and right use of English is absolutely essential to culture among English-speaking people; and one may become expert in science, mathematics, and the industrial arts, but if he does not possess the ability to use good English, he is considered to be lacking in culture.

A command of English is obtained only through careful study and wise use. One should always avail himself of the opportunities at his command in perfecting himself in any art, and the correspondence student has special advantages in the opportunities offered for perfecting himself in the use of English. Among these are:

1. The necessity of committing his thoughts to writing. We acquire many bad habits of speech through looseness of thought and carelessness of expression. When we commit our thoughts to writing we are naturally more careful about their arrangement and the manner in which they are expressed.

2. The opportunity for careful review and correction of his work. The correspondence student can and should review and criticise his work thoroughly before allowing it to pass out of his hands. One who forms the habit of

doing this makes continual advancement in his command and use of language.

3. Written criticisms from his instructors. The instructors in the Interstate School of Correspondence are men and women of ripe scholarship and extended experience as teachers. Their criticisms are carefully made, and of the highest value. The verbal criticism of the class room may be, and often is, forgotten, but the written criticism of the correspondence instructor can be preserved for reference as long as needed. By carefully studying these criticisms, one learns to avoid possible errors.

It does not necessarily follow that one who writes fluently and accurately will speak correctly. He may have formed in childhood bad habits of speech which have become second nature to him, and which betray him when he is least aware of their presence. By persistent effort bad habits of speech can be conquered, and one who values a reputation for scholarship and culture should conquer them at whatever cost.

The choice of words is an important element in one's use of language. By reading the best authors, such as Dickens, Hawthorne, Lowell, and Emerson, one soon learns that they use short, simple words. In their vocabulary is found the principal charm of their writings, and we turn to their pages with pleasure, while those writers who draw their vocabulary principally from the Latin element in the language soon become tiresome.

By reading and by conversation with people of culture acquire a good vocabulary of pure English words, then use them with force and life in expressing your thoughts, and you will soon possess the ability to make yourself felt as a conversationalist, a speaker, or a writer.

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ARITHMETIC

ARITHMETIC.

PERCENTAGE.

Percentage is the process of computing by hundredths. Any per cent is a fraction whose denominator is 100, and whose numerator is the number indicating the per cent. Since percentage is based on the decimal scale, its processes are the most convenient for business purposes. For this reason percentage is usually considered as the "business part" of arithmetic.

The principles and operations in percentage are identical with those discussed under common and decimal fractions. In the preceding number you have studied and applied all the different forms of analysis necessary to an understanding of percentage.

The terms in common use in arithmetic are base, rate, and percentage.

The base is the number upon which the percentage is reckoned.

The rate is the per cent used as a multiplier.

The percentage is the result obtained by taking the required per cent of a number.

While you need to understand these terms on account of their use in text-books, they are of little or no use in the solution of problems.

The solution of every problem is a process in reasoning, as well as a process in numbers, and unless your work in arithmetic is based primarily on the reasoning process, all your knowledge of definitions and rules will be of little value. See *Instruction Book I*, page 1. NOTE.

The common fractions most used in business and their equivalent per cents are shown in the following table. There are besides a few decimals in common use as per cents that do not have convenient equivalent common fractions; such as .06, .05½, .07, etc.

	I	II	III	IV	V	VI	VII	VIII
	3	7	13	9	5	21	19	17
A	$\frac{1}{2}$	.50	$\frac{1}{5}$	.20	$\frac{5}{6}$	.83$\frac{1}{3}$	$\frac{1}{12}$	.08$\frac{1}{3}$
B	$\frac{1}{3}$	.33$\frac{1}{3}$	$\frac{2}{5}$	.40	$\frac{1}{8}$	.12$\frac{1}{2}$	$\frac{5}{12}$	.41$\frac{2}{3}$
C	$\frac{2}{3}$	.66$\frac{2}{3}$	$\frac{3}{5}$	.60	$\frac{3}{8}$	.37$\frac{1}{2}$	$\frac{1}{16}$	.06$\frac{1}{4}$
D	$\frac{1}{4}$	.25	$\frac{4}{5}$	.80	$\frac{5}{8}$	.62$\frac{1}{2}$	$\frac{3}{16}$	.18$\frac{3}{4}$
E	$\frac{3}{4}$	.75	$\frac{1}{6}$	.16$\frac{2}{3}$	$\frac{7}{8}$	.87$\frac{1}{2}$	$\frac{5}{16}$	.31$\frac{1}{4}$
	.15	.06	.7	.125	.12	.00$\frac{1}{3}$	.14	.00$\frac{7}{8}$
	IX	X	XI	XII	XIII	XIV	XV	XVI

This table is susceptible of almost any number of combinations and you should give it sufficient attention to enable you to change any number which it contains into its equivalent in the other form as readily as you can give the product of two times six. The numbers outside the double horizontal lines are to be used as multipliers and divisors. The numbers within the double horizontal lines afford numerous exercises in addition since they can be added in any direction desired. The multipliers and divisors can be used as follows: Multiply A—III means that each number in line A is to be multiplied by 13. Divide D—X means that each number in line D is to be divided by .06. A little study will reveal to you an infinite number of combinations of this sort.

The problems in percentage can be grouped under three classes.

I. Finding any part (any per cent) of a number. (1)

II. Finding what part (what per cent) one number is of another. (2).

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(1) (a) Find 15% of 540.

1% of 540 =.01 of 540, or 5.4.

15% =5.4×15, or 81.

(b) Find $12\frac{1}{2}$% of 72.

$12\frac{1}{2}\% = \frac{1}{8}$; $\frac{1}{8}$ of 72=9.

(c) Find $\frac{2}{3}$% of 2400.

1 % of 2400=24; $\frac{2}{3}$% of 2400=$\frac{2}{3}$ of 24, or 16.

From the above analyses we derive the following rule for finding any per cent of a number:

Find one per cent of the number and multiply this by the given rate; or reduce the given rate to an equivalent common fraction and take this fractional part of the number.

This reduces to: *Multiply the number by the rate per cent.*

(2) (a) What per cent of 75 is 15 ?

$15 = \frac{1}{5}$ of 75; $\frac{1}{5}$=20%.

(b) What per cent of 450 is 87 ?

1% of 450=4.5.

87÷4.5=$19\frac{1}{3}$, therefore 87 is $19\frac{1}{3}$% of 450.

(c) What per cent of $\frac{11}{12}$ is $\frac{5}{6}$?

1% of $\frac{11}{12}=\frac{11}{1200}$.

$\frac{5}{6}\div\frac{11}{1200}=\frac{5}{6}\times\frac{1200}{11}$, or $\frac{750}{11}$.

$\frac{750}{11}=68\frac{2}{11}$%, therefore $\frac{5}{6}$ is $68\frac{2}{11}$% of $\frac{11}{12}$.

Or, $\frac{11}{12}=\frac{88}{96}$, $\frac{5}{8}=\frac{60}{96}$.

1% of 88=.88; 60÷.88=$68\frac{2}{11}$, therefore

$\frac{5}{8}$ is $68\frac{2}{11}$% of $\frac{11}{12}$.

From the above analyses we derive the rule for finding what per cent one number is of another :

Find what fractional part the percentage is of the number and reduce this fraction to its equivalent per cent; or *find one per cent of the number and divide the percentage by it.*

This reduces to:

Divide the number denoting the percentage by the number with which it is compared, and extend the division into hundredths.

III. Finding a number when any part (any per cent) of it is given. (3)

You should compare the analysis of these three classes of problems with the corresponding analysis under fractions and decimals, and apply each of them to a sufficient number of problems to enable you to readily see under what conditions each should be used.

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(3) (a) Of what number is 525 15%?
1% of the number=525÷15, or 35.
100% of the number=35×100, or 3500.

(b) Of what number is 84 $12\frac{1}{2}$%?
$12\frac{1}{2}\% = \frac{1}{8}$; 84×8=672.

(c) 720 is 20% more than what number?
By the statement 720=120% of the required number. and 1% will=720÷120, or 6.
6×100=600.
Or, 20%=$\frac{1}{5}$. $\frac{5}{5}+\frac{1}{5}=\frac{6}{5}$.
720=$\frac{6}{5}$ of the number.
$\frac{1}{5}=\frac{1}{6}$ of 720, or 120.
$\frac{5}{6}$=120×5, or 600.

(d) 1200 is 10% less than what number?
According to the statement 1200=90% of the required number. 1%=1200÷90, or $13\frac{1}{3}$.
100%=$1333\frac{1}{3}$.
Or, 1200=$\frac{9}{10}$ of the required number.
$\frac{1}{10}=\frac{1}{9}$ of 1200, or $133\frac{1}{3}$.
$\frac{10}{10}=133\frac{1}{3}\times 10$, or $1333\frac{1}{3}$.

To find a number when any per cent of it is given:

Determine what fractional part of the required number is given. Find the value of the fractional unit and multiply this by the denominator of the fraction. Or,

Divide the given number by the number denoting the rate per cent.

Many problems in percentage are readily solved by the use of the equation. Let x equal the number required as in illustration (d), then:

$.90x = 1200.$
x=1200÷.90, or $1333\frac{1}{3}$.

While the complete analysis can be replaced by a shorter process, it is unwise to attempt the short process too soon.

You arrive at an intelligent use of the short process only through a thorough understanding of the complete process given in the analysis.

The application of these three classes of problems is made under two divisions.

The first division includes all applications of percentage as a simple factor.

The second division includes all applications of percentage as a compound factor, and contains the additional element of time.

The applications under the first division are in finding parts of quantities, profit and loss, commission and brokerage, insurance, taxes, duties and customs, and commercial discounts. (4) The problems given involve the

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(4) The definitions of terms under these heads are found in any good text-book, and should be looked up in connection with your study of this number.

PROBLEMS.

Class I. 1. Find $8\frac{1}{4}\%$ of 2769; of 36521; of .0025.

2. Find $\frac{2}{3}\%$ of $87\frac{1}{2}$; of 2069; of 35.63.

3. Find the difference between 50 % of 496 and $\frac{1}{2}$ % of the same number; between $33\frac{1}{3}\%$ of 669 and $\frac{1}{3}\%$ of the same number.

4. A clerk who received $325 a year had his salary increased 40%; what does he receive now? Property which cost $3,256 increased in value 125%. What was the new value?

5. A house that cost $360 was sold at a gain of 18%. How much was received for it? E bought 2,360 bu. of wheat at $.85 per bushel, and sold it at a gain of $18\frac{1}{4}\%$. How much did he get for it?

6. (a) An agent sold goods to the amount of $1,260. What is his commission at $3\frac{1}{2}\%$? (b) If $7,415 be sent to an agent to purchase wheat, how many bushels can he buy at $.85 per bushel after deducting

application of the principles and analyses which you have been studying in the previous number and in the first part of this one.

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his commission of 2%? Note that in the last part of this problem, the amount sent includes the commission. The employer sends $1.02 for every dollar expended. What difference in principle is involved in the two parts of the problem? Solution:

(a) 3½% of $1260=$44.10, commission.
(b) $7415÷1.02=$7269.61, amt. to be invested.
$7269.61÷$.85=8552.48, no. bushels.

7. (a) What is the commission at 2½% for selling 680 bu. of wheat at $1.10 per bushel? (b) An agent collects $3,450. How much does he remit to his employer after deducting a commission of 5%?

8. On a bill of $230 what is the difference between a discount of 45%, and the successive discounts of 25%, 15% and 5%?

Solution:

45% of $230=$103.50, discount.
25% of $230=$57.50; $230−$57.50=$172.50.
15% of $172.50=$25.88; $172.50−$25.88=$146.62.
5% of $146.62=$7.33.
$57.50+$25.88+$7.33=$90.71, total discounts.
$103.50−$90.71=$12.79, difference.

CLASS II. 1. $34.32 is 13% of what? $64.98 is 19% of what?

2. The assessed value of a city is $250,000. (a) What must be the per cent of taxation to raise $10,000? (b) What will be the net sum for public purposes if the collector is able to collect only 95% of the tax, and charges 2% on the amount collected, for his services? Solution.

(a) $10,000÷$250,000=.04, rate of taxation.
(b) 95% of $10,000=$9,500, amt. collected.
2% of $9,500=$190, commission.
$9,500−$190=$9,310, net proceeds.

3. A town containing 390 polls, assessed at $1 each, has an assessed valuation of $987,680. The amount of tax to be raised is $5,822.24. What is the rate of taxation?

4. A factory worth $45,000 is insured for ⅔ of its value, at 1¾%. How much is the premium? If a premium of $75 is paid for an insurance of $6,400 on a house, what is the rate of insurance?

You should determine the analysis of the problem from its conditions, then proceed to solve it carefully.

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5. If goods are bought for $8,728, and sold for $9,819, what is the gain per cent?

6. A farmer buys 18 head of cattle at $25 a head, and after losing three, sells the remainder at $38 a head. What is his gain per cent?

CLASS III. 1. A man paid $225, which was 33⅓% less than the amount owed. What is still due? Sold goods at a gain of 22%. The profit was $47.80. For how much were they sold?

2. Owning 80% of a ship, I sold 25% of my share for $19,800. What is the value of the entire ship?

3. Bought two horses for $250 each, and sold one at a gain of $37.50, and the other at a loss of $37.50. Required, the rate per cent of gain or loss, and the selling prices.

4. A merchant buys, through an agent, 480 yards of carpet at $.80 a yard, and pays ¾% commission. The freight amounted to $1.92. At what price per yard must the carpet be sold to realize a profit of 33⅓%.

5. What is the amount of sales when the brokerage is $64 at ¾%? What is the amount of sales when the net proceeds are $2,493.16, brokerage ¾%?

6. What is the valuation of a piece of property that pays $273 at a rate of 3¼ mills on the dollar?

7. 544 is 15% less than what number? 545 is 25% more than what number? 510 is 170% of what number?

8. By a mistake in weighing, an amount of coal so much less than a ton was sold for a ton that the seller gained 8%. What part of a ton was sold for a ton? What per cent did the buyer lose?

9. C collected a sum of money for D. He deducted his commission of 6%, and paid over the balance, which was $350.15. How much did he collect? What was the amount of his commission?

MISCELLANEOUS PROBLEMS.

1. A merchant sells lumber which cost $15 per M at 2 cents a foot. What is his gain per cent?

2. B sold a farm for $97.75 per acre, which was 18% more than it cost him. What did he pay for it per acre?

3. How many dollars' worth of goods can be bought for $950, after deducting the agent's commission of 2½%?

Place all your work in the form of the equation, prove each result by a careful review of the process by which it was obtained; make plain figures, and give your work a neat and finished appearance.

Certain problems under commission need to be carefully distinguished. Such are problems 3 and 4 under *Miscellaneous Problems.* In 3 the amount contains the commission. In other words the \$950 is $102\frac{1}{2}\%$ of the sum to be invested. The agent gets commission only on the sum invested, not on the entire amount, \$950. In problem 4 the agent gets 3% on each dollar collected, and the amount forwarded would be \$5,450 less 3% of itself. *In each case the agent gets a commission on the money handled in the interest of the employer.*

Commercial discount is reckoned by deducting each succeeding discount from the amount of the bill after the preceding discount has been subtracted.

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4. An agent collected \$5,450; how much does he remit to his employer after deducting his commission of 3%?

5. An agent receives \$7,565 to invest in cotton at $8\frac{2}{3}$ cents a pound. If his commission is $2\frac{1}{2}\%$ how many pounds of cotton can he buy?

6. A vessel valued at \$135,000 is insured for $\frac{3}{4}$ of its value at a premium of $3\frac{3}{8}\%$. What is the loss to the owners if the vessel is destroyed? What is the loss to the insurance company?

7. How many gallons of water must be mixed with $70\frac{1}{2}$ gallons of wine in order to have the mixture contain 5% of water?

8. A man gained 25% on the sale of a horse; 3% on the sale of a buggy; and lost 15% on the sale of a carriage. The selling price of each was \$150. What was the cost of each? What was his net gain or loss?

9. You own 160 acres of land. Its assessed value is \$36 per acre. If your state tax is $\frac{1}{3}\%$, your county tax 2%, your town tax $\frac{1}{4}\%$, your school tax $2\frac{1}{2}\%$, and your road tax $\frac{1}{8}\%$, what is the amount of tax which you will have to pay?

STUDIES.

I.

1. Study the multiplication of decimals:

(a) Multiplying a whole number by a decimal. Analyze the process. See note 13, second number. Deduce the principle for fixing the decimal point.

(b) Multiplying a decimal by a decimal. Analyze the process. See note 14, second number. Compare these analyses with those in the multiplication of common fractions.

2. Study the division of decimals. See note 15, second number. Analyze each process and deduce the principle for fixing the decimal point:

(a) Division of a decimal by a whole number. (b) Division of a whole number by a decimal. (c) Division of a decimal by a decimal.

Compare the analyses of these processes with those in the division of common fractions.

II.

Make a study of denominate numbers from your arithmetic according to the following plan:

1. Learn the tables in common use, viz., linear measure, square measure, cubic measure, circular measure, avoirdupois weight, troy weight, apothecaries' weight.

2. Practice the reductions from one denomination to another, under the different tables until you are familiar with them.

III.

1. Define base, rate, percentage.

2. Study finding any per cent of a number:

(a) Analyze the process. See note 1. Compare with the multiplication of a whole number by a decimal.

(b) Apply the principle as follows:

(1) Finding gain or loss when the cost and rate are given.

(2) Finding commission when the amount and rate are given.

(3) Finding the premium of insurance when the face of the policy and rate are given.

(4) Computing one's tax when the assessed valuation and rate are given.

Look up definitions of the terms used in the above headings unless you are already familiar with them.

IV.

Study finding what per cent one number is of another, or finding the rate.

1. Analyze the process. See note 2.

2. Apply to finding the rate when the percentage and the amount on which the percentage is reckoned are given, in profit and loss; commission; insurance; taxes.

V.

Study finding a number when the rate and percentage are given:

(a) Analyze the process. See note 3. (b) Compare this analysis with that for finding the rate. Are the principles the same? (c) Apply this process under the headings already given as indicated in your arithmetic.

Notice the use of this process in commission, when the amount forwarded includes both the commission and the amount to be invested.

ELEMENTARY ALGEBRA

SPECIAL RULES IN MULTIPLICATION.

Certain products are required so often in algebra that it is a great saving of time and work if you are able to write them without performing the multiplication. This is termed writing *by inspection.*

I. $(a+b)(a+b)=(a+b)^2$ and is read, *the square of* $(a+b)$. Perform these multiplications and study the products:

$$\begin{array}{r} a+b \\ a+b \\ \hline a^2+ab \\ ab+b^2 \\ \hline a^2+2ab+b^2 \end{array} \qquad \begin{array}{r} x+y \\ x+y \\ \hline x^2+xy \\ xy+y^2 \\ \hline x^2+2xy+y^2 \end{array}$$

Place these in the form of equations and you have $(a+b)^2=(a+b)(a+b)$, or $(a+b)^2=a^2+2ab+b^2$.
$(x+y)^2=x^2+2xy+y^2$.

The study of these illustrative problems should enable you to understand the following principle:

The square of the sum of two quantities is equal to the square of the first, plus twice the product of the first by the second, plus the square of the second.

Write the products of the following binomials *from inspection.* The value of the exercise depends wholly upon your observing this direction.

NOTE.—Save for further use the products obtained in each exercise under these special rules.

1. $(a+b)^2$; $(m+n)^2$; $(x+y)^2$; $(b+2)^2$; $(x^2+y^2)^2$.

2. $(3a^2+2b)^2$; $(x^m+y^n)^2$; $(x+4)^2$; $(x^3+3y^4)^2$; $(4a^4+3b^2)^2$.

II. Now multiply $a-b$ by $a+b$ and compare the result with that obtained in I:

$$\begin{array}{r} a-b \\ a-b \\ \hline a^2-ab \\ \quad -ab+b^2 \\ \hline a^2-2ab+b^2 \end{array} \qquad \begin{array}{r} x-y \\ x-y \\ \hline x^2-xy \\ \quad -xy+y^2 \\ \hline x^2-2xy+y^2 \end{array}$$

The square of the difference of two quantities is equal to the square of the first, minus twice the product of the first by the second, plus the square of the second.

Write the following products from inspection:

1. $(a-b)^2$; $(x-y)^2$; $(m^2-n)^2$; $(2x-a)^2$; $(z-y)^2$.

2. $(4a-2b)^2$; $(3x^2y-y^2)^2$; $(xy^2-y^3)^2$; $(a-5)^2$; $(4-xy)^2$.

III. Now multiply $a+b$ by $a-b$ and observe the product in this and each of the other multiplications:

$$\begin{array}{r} a+b \\ a-b \\ \hline a^2+ab \\ \quad -ab-b^2 \\ \hline a^2 \quad -b^2 \end{array} \qquad \begin{array}{r} x-y \\ x+y \\ \hline x^2-xy \\ \quad xy-y^2 \\ \hline x^2 \quad -y^2 \end{array} \qquad \begin{array}{r} a+3 \\ a-3 \\ \hline a^2+3a \\ \quad -3a-9 \\ \hline a^2 \quad -9 \end{array}$$

The product of the sum and difference of two quantities is equal to the difference of their squares.

Write the following products from inspection:

1. $(m+n)(m-n)$; $(a^4+b^2)(a^4-b^2)$; $(3ax+y)(3ax-y)$; $(4a^2b+2b^2)(4a^2b-2b^2)$; $(5a+bx)(5a-bx)$

2. $(3x^2+2y^2)(3x^2-2y^2)$; $(4a+7b)(4a-7b)$; $(a^{mn}+b^n)(a^{mn}-b^n)$; $\left(\frac{3}{4}a+\frac{1}{2}b\right)\left(\frac{3}{4}a-\frac{1}{2}b\right)$; $(3^2+x)(3^2-x)$.

IV. Find the product of:

1. $(x+3)(x+5)$. 2. $(x+3)(x-5)$. 3. $(x-3)(x-5)$.

$x+3$	$x+3$	$x-3$
$x+5$	$x-5$	$x-5$
x^2+3x	x^2+3x	x^2-3x
$5x+15$	$-5x-15$	$-5x+15$
$x^2+8x+15$	$x^2-2x-15$	$x^2-8x+15$

How is the first term in each of the above products obtained?

To what is the second term equal? The third term?

Study these multiplications until you understand thoroughly the following principle:

The product of two binomials having a common term is equal to the square of the common term, the algebraic sum of the unlike terms multiplied by the common term, and the algebraic product of the unlike terms.

Write the following products from inspection:

1. $(x+4)(x-2)$; $(a^2+3)(a^2+4)$; $(y^2-3x)(y^2-2x)$; $(4m+8n)(4m-3n)$; $(5x^2y+8)(5x^2y-8)$.

2. $(5+x)(5-y)$; $(4x^4y+3y^2x)(4x^4y-2y^2x)$; $(5a^{mn}+3)(5a^{mn}-4)$; $(x-6y)(x+10y)$; $(3x-1)(2x+1)$.

V. $(a+b)(a+b)(a+b)=(a+b)^3$.

Prove by multiplication that $(a+b)^3=a^3+3a^2b+3ab^2+b^3$. Prove that $(x+y)^3=x^3+3x^2y+3xy^2+y^3$. Prove that $(3a+2b)=^3 27a^3+54a^2b+36ab^2+8b^3$.

A careful study of these multiplications should enable you to see that they embody the following principle:

The cube of the sum of two quantities is equal to the cube of the first, plus three times the square of the first multiplied by the second, plus three times the square of the second multiplied by the first, plus the cube of the second.

Write the following products from inspection:

1. $(m+n)^3$; $(c+d)^3$; $(a^2+c)^3$; $(x+y^2)^3$; $(t+u)^3$.

2. $(2a+b)^3$; $(4x+2y)^3$; $(y+3z)^3$; $(5a^2+2b)^3$; $(6x^2+3b^2)^3$.

Your success in the operations which follow depends very largely upon the complete mastery of these special rules for multiplication, and you should drill upon them until you can write the products at sight.

DIVISION.

Division is the process of finding one factor when the product and the other factor are given. Division is the converse of multiplication.

The dividend is the number to be divided and corresponds to the product in multiplication.

The divisor is the given factor.

The quotient is the factor that is required.

As in arithmetic, division in algebra may be expressed in two ways:

1. By writing the divisor after the dividend with the sign $\div$ between: as, $4\div 2$, $a\div b$.

2. By writing the quantities in the form of a fraction: as $\frac{4}{2}$, $\frac{a}{b}$.

By multiplying $+5$ by $+3$ we get $+15$. If we divide $+15$ by $+3$, what is the quotient?

$+5\times -3=-15$; what does $-15\div -3$ equal?

$-5\times -3=+15$; what does $+15\div -3$ equal?

What does $-15\div 5$ equal?

What does $15\div -5$ equal?

Prove in each case that your quotient is right by multiplying the quotient and divisor together. The product should be the dividend.

From this study you should be able to discover the law of signs in division.

Like signs produce + and unlike signs produce −.

$+15 \div +3 = +5$; $-15 \div -3 = +5$; $-15 \div +3 = -5$; $ab \div a = b$; $-ab \div -a = b$; $ab \div -a = -b$; $-ab \div a = -b$.

If we multiply a by a we have a^2; a^2 by a, a^3; a^3 by a, a^4, and so on. What does $a^2 \div a$ equal? $a^3 \div a = ?$ $a^3 \div a^2 = ?$ $a^4 + a^3 = ?$

How do you obtain the exponents in the product? Since division is the converse of multiplication, how should the exponents in the quotient be obtained?

The answers to these questions should lead you to discover the law of exponents in division:

The exponents of any term in the quotient are equal to the difference between the exponents of like terms in the dividend and divisor.

I. Division of Monomials. The division of monomials is similar to division in arithmetic.

Divide the coefficient of the dividend by the coefficient of the divisor, for the coefficient of the quotient.

Subtract the exponents of the literal quantities of the divisor from those of similar quantities in the dividend, for the exponents of the quotient.

EXERCISE.

1. $14a^2b \div 2a = ?$
2. $16x^3y^2 \div -4x^2y = ?$
3. $27mn \div 3m = ?$
4. $64a^4b^3c \div -16a^3b^2 = ?$
5. $35a^m b^n \div 7a_m = ?$
6. $(abc)a \div -bc = ?$
7. $x^4y^3z^2 \div zx^2 = ?$
8. $\dfrac{m^4n^3y}{n^2y} = ?$
9. $\dfrac{8x^4y^2}{-2xy} = ?$
10. $\dfrac{(4c^3d^2)x}{(4c^3d^2)y} = ?$

II. Division of Polynomials by Monomials.

Divide each term of the polynomial by the monomial, observing the laws of signs and exponents.

EXERCISE.

Divide:

1. $3a^2-2a$ by a.
2. $8x^4+4x$ by $-2x$.
3. $10a^3x-8ax^2+4ax^3$ by $-2ax$.
4. $-15x^4y^3z^2+24y^4x^3z-18z^3y^2x^2$ by $3xy^2$.
5. $15x^5-25x^4-10x^3$ by $-5x^3$.

Ans. $-3x^3+5x^2+2x$.

6. Find the value of $\dfrac{(8y^2+4y-2)xy}{2xy}$.
7. Find the value of $\dfrac{(2a+3b)(a-b)x}{(a-b)y}$.

Ans. $\left(\dfrac{2a+3b}{y}\right)x$ or $\dfrac{2ax+3bx}{y}$

8. $\dfrac{18m^3n^5-45m^6n^7-36m^4n^9}{-3m^4n^5}=?$

Ans. $-6m^4+15m^2n^2+12n^4$.

9. Divide $x(a+b)^2-xy(a+b)^3+x^2y^2(a+b)^4$ by $x(a+b)^2$.

Ans. $1-y(a+b)+xy^2(a+b)^2$.

10. Divide $a^{n+2}b^{q+1}c^3-a^nb^qc^4-a^mb^qc^r$ by $-a^nb^qc^3$

Ans. $-a^2b+c+a^{m-n}c^{r-3}$.

III. Division of Polynomials by Polynomials.

Review the special rules of multiplication.

How do you obtain the product $x^2+2xy+y^2$? If you have this product and the factor $x+y$ given, how can you find the other factor? What will it be? In the quantity $a^3+3a^2b+3ab^2+b^3$, how are the powers of a and b arranged? Of what factors is this expression the product?

If you divide $a^3+3a^2b+3ab^2+b^3$ by $a+b$ what will you obtain for a product?

Division of polynomials is similar in its process to long division in arithmetic.

Divide $x^2+2xy+y^2$ by $x+y$.

Dividend $x^2+2xy+y^2$ ($x+y$ Divisor

x^2+xy $\quad x+y$ Quotient

$xy+y^2$

$xy+y^2$

Divide $6x^2+xy-2y^2$ by $2x-y$.

Dividend $6x^2+xy-2y^2$ ($2x-y$ Divisor

$6x^2-3xy$ $\quad 3x+2y$ Quotient

$4xy-2y^2$

$4xy-2y^2$

Divide $x^3-5x^2y+9xy^2-9y^3$ by $x^2-2xy+3y^2$.

$x^3-5x^2y+9xy^2-9y^3$ ($x^2-2xy+3y^2$

$x^3-2x^2y+3xy^2$ $\quad x-3y$

$-3x^2y+6xy^2-9y^3$

$-3x^2y+6xy^2-9y^3$

Study these illustrative examples and answer the following questions:

1. How was the first term of the quotient obtained?
2. What use is made of this term?
3. How is the second dividend obtained?
4. How is the second term in the quotient obtained?
5. How do you know the quotient is complete?

When you can answer these questions satisfactorily you will understand the process and can go on with the work. Proceed according to the following rules:

1. *Arrange the terms of the dividend and divisor according to the descending powers of the leading letter.*

2. *Divide the first term in the dividend by the first term in the divisor.*

3. *Multiply the terms of the divisor by the term of the quotient thus obtained, and subtract the product from the dividend.*

4. *To the difference add the unused terms of the dividend and proceed as before. Continue the operation until all terms of the dividend have been used, or until the division cannot be carried further.*

In solving problems in division of polynomials you will need to bear in mind that as you subtract you must change the signs of the terms. Beginners are liable to overlook this point and in consequence have much difficulty.

EXERCISE.

Divide:

1. a^2+3a+2 by $a+1$.
2. $b^2-7b+12$ by $b-3$.
3. $5x^3+16x+3$ by $x+3$.
4. $2a^3-a^2+3a-9$ by $2a-3$. Ans. a^2+a+3
5. $6a^4-96$ by $3a-6$. Ans. $2a^3+4a^2+8a+16$.
6. $x^6-3x^4y^2+3x^2y^4-y^6$ by $x^3-3x^2y+3xy^2-y^3$.
   Ans. $x^3+3x^2y+3xy^2+y^3$.
7. $-15a^4+37a^3bd-29a^2cf-20b^2d^2+44bcdf-8c^2f^2$ by $3a^2-5bd+cf$.
8. a^4-b^4 by $a-b$.
9. $3x^4-8x^2y^2+3x^2z^2+5y^4-3y^2z^2$ by $x-y$.
10. x^5+32y^5 by $x+2y$.
    Ans. $x^4-2x^3y+4x^2y^3-8xy^3+16y^4$.
11. a^6b^6-64 by $ab-2$.

12. $48x^2y^3+26xy^4-17x^3y^2+8x^5-22x^4y-8y^5$ by $2x^2-4y^2-3xy$.

13. $a^4-2a^3-7a^3+8a+12$ by a^2-a-6.

Ans. a^2-a-2.

14. $a^5+4a^3-92a-3a^4+26a^2+55$ by $a^2-3a+11$.

15. $3x^5+4x^3y^2+4x^2y^3+xy^4+4y^5$ by $x^3+x^2y+xy^2+y^3$.

Ans. $3x^2-3xy+4y^2$.

16. $x^3+(-a+b-c)x^2+(-ab-bc+ca)x+abc$ by $x^2+(-a+b)x-ab$. Ans. $x-c$.

17. $14a^4-23a+6a^6+6a^2-11a^5+5-12a^3$ by $5a-3a^2+2a^3-1$.

18. $x^{4n}+x^{2n}y^{2n}+y^{4n}$ by $x^{2n}-x^ny^n+y^{2n}$.

19. $x^3+(a-b-c)x^2+(-ab+bc-ca)x+abc$ by $x^2-(b+c)x+bc$.

20. $x^3-3x^2y+y^3$ by $x+y$. Ans. $x^2-4xy+4y^2-\frac{3y^3}{x+y}$.

Send in 14, 17 and 19 with your recitation paper.

SPECIAL RULES IN DIVISION.

Since division is the converse of multiplication, each of the special rules in multiplication establishes a similar rule in division. You should become as familiar with these rules as with those in multiplication. Practice the exercises under each until you can write the quotients of corresponding expressions by inspection.

1. *The square of the sum of two quantities is divisible by the sum of the quantities.* $x^2+2xy+y^2\div x+y=x+y$.

2. *The square of the difference of two quantities is divisible by their difference.* $x^2-2xy+y^2\div x-y=x-y$.

3. *The product of the sum and difference of two quantities or the difference of their squares is divisible by the sum of the quantities, also by their difference.* $x^4-y^4\div x^2-y^2=x^2+y^2$. $x^4-y^4\div x^2+y^2=x^2-y^2$.

4. *The sum of the cube of two quantities is divisible by the sum of the quantities; also by the sum of their squares minus their product.* $x^3+y^3\div x+y=x^2-xy+y^2$; $x^3+y^3\div x^2-xy+y^2=x+y$.

5. *The difference of the cube of two quantities is divisible by the difference of the quantities; also by the sum of the squares of the quantities plus their product.* $x^3-y^3\div x-y=x^2+xy+y^2$. $x^3-y^3\div x^2+xy+y^2=x-y$.

6. *The difference between the fourth powers of two quantities is divisible by the sum of the quantities, by their difference, by the sum of their squares and by the difference of their squares.*

$x^4-y^4\div x+y=x^3-x^2y+xy^2-y^3$.
$x^4-y^4\div x-y=x^3+x^2y+xy^2+y^3$.
$x^4-y^4\div x^3+y^2=x^2-y^2$.
$x^4-y^4\div x^2-y^2=x^2+y^2$.

EXERCISE.

Apply these special rules of division and write the quotients by inspection. At first you may find it advisable to prove your work by multiplying the quotient by the divisor.

1. $a^2+2ab+b^2\div a+b$.
2. $x^2-2xy+y^2\div x+y$.
3. $c^3-d^3\div c+d$.
4. $4x^2-9y^2\div 2x+3y$.
5. $a^3+b^3\div a+b$.
6. $x^3-y^3\div x-y$
7. $8x^3+y^3\div 2x+y$.
8. $a^4-b^4\div a-b$
9. $c^4-d^4\div c^3-c^2d+cd^2-d^3$.
10. $16a^4-81b^4\div a-b$.

ZERO AND NEGATIVE EXPONENTS.

When the exponent in the divisor is equal to or greater than that in the dividend, zero or negative exponents arise in the quotient.

I. Zero exponents:

$a \div a = a^0$, but $a \div a = 1$; therefore,

$a^0 = 1$. $10 \div 10 = 10^0$ or 1. $100 \div 100 = 100^0$ or **1.**

Any quantity whose exponent is 0 *is equal to unity.*

Do not confound 0 used as a coefficient with 0 used as an exponent.

$a \times 0 = 0$: $a^0 = 1$.

$5 \times 0 = 0$: $5^0 = 1$.

II. Negative exponents.

The exponents in the quotient are obtained by subtracting those of the divisor from those of the dividend. When the exponents are equal the factors are cancelled; when the exponent of the divisor is greater than that of the dividend the factor appears in the quotient with a negative exponent equal to the difference.

$$a^3 \div a^2 = a$$
$$a^3 \div a = a^2$$
$$a^3 \div a^3 = a^0$$
$$a \div a^2 = a^{-1}$$
$$a \div a^3 = a^{-2} \text{ and so on.}$$

Placing the same expressions in fractional form, we have:

$$\frac{a^3}{a} = a^2; \quad \frac{a^3}{a^2} = a; \quad \frac{a^3}{a^3} = a^0; \quad \frac{a}{a^2} = a^{-1}; \quad \frac{a}{a^3} = a^{-2} \text{ and so on.}$$

But, $\frac{a}{a^2} = \frac{1}{a}$; $\frac{a}{a^3} = \frac{1}{a^2}$; $\frac{a}{a^4} = \frac{1}{a^3}$ and so on.

In each case we have obtained the exponent in the quotient by subtracting that of the divisor from that of the dividend.

The reciprocal of a quantity is the quotient arising

from dividing 1 by that quantity; the reciprocal of a is $\frac{1}{a}$, of b, $\frac{1}{b}$; of a^3, $\frac{1}{a^3}$ and so on. But we have seen that $\frac{1}{a}=a^{-1}$; $\frac{1}{a^2}=a^{-2}$ and $\frac{1}{a^3}=a^{-3}$ and so on; therefore,

The value of a quantity having a negative exponent is equal to the reciprocal of the quantity with an equal positive exponent.

In the expressions $\frac{1}{a}=a^{-1}$ and $a^{-2}=\frac{1}{a^2}$ we notice that a has been transferred in the first instance to the denominator of a fraction and in the second instance from the denominator, by changing the sign of its exponent. Since the numerator represents the dividend and the denominator the divisor, we have the following additional principle of negative exponents:

Any factor may be transferred from one term of a division to the other, provided the sign of its exponent be changed.

EXERCISE.

1. What is the value of a^{n-2} when $n=3$?
2. What is the value of $x^2\times x^3\times x^{-5}$?
3. Reduce the expression $\frac{5x^2y^{-1}z^{-4}}{6x^2m^{-3}d}$ to an equivalent expression having positive exponents. Ans. $\frac{5m^3}{6yz^4d}$.
4. Reduce to positive exponents, $6x^{-1}y^3z\div 2xyz^{-3}$; $2^{-1}x^{-3}\div y^{-1}$.
5. Reduce to positive exponents, $(3xy^{-4}z\times 2^{-2}yz)\div \frac{3}{4}\times y^{-3}z^2$.

GRAMMAR AND ANALYSIS

GRAMMAR AND ANALYSIS.

THE PREPOSITION.

A preposition is a word used to connect a noun or pronoun with some other word in the sentence and show the relation between them. *My friend came* ON *the train.* The relations expressed by prepositions are usually those of time, place, cause and purpose.

The object of the preposition is the word used with it. *Henry went into the* HOUSE.

A prepositional phrase is formed by the preposition and its object, taken together. *I shall go* BEFORE NOON.

The object of a preposition may be:

(1) A noun: *He went to* BOSTON.

(2) A pronoun: *John sent the books to* YOU.

(3) A gerund: *After* WALKING *a mile, I came to the bridge.*

(4) An adjective: *He spoke of the* GOOD *which they had done.*

(5) An adverb: *The sound came from* WITHIN.

(6) A phrase used as a noun: *The enemy came from* BEYOND THE RIVER.

(7) A clause used as a noun: *I shall be guided by* WHAT HE SAYS.

The parts of speech to which a preposition may connect its object are:

(1) A verb: *The child* CAME *to me.*

(2) A gerund: SAILING *on the lake is pleasant pastime.*

(3) An infinitive: *You were asked* TO GO *before noon.*

(4) A noun: SUCCESS *in business made him wealthy.*

(5) A pronoun: *For* WHICH *of these faults am I blamed?*

(6) An adjective: *The* GRANDEST *of scenes was before me.*

(7) An adverb: *A poor workman seldom makes anything* EXACTLY *to order.* This construction is seldom found.

A preposition may have two or more objects: *The misunderstandings between* EMPLOYERS *and* EMPLOYES *have caused many labor strikes.*

When a word that is usually a preposition has no governing word it becomes a noun, an adjective or an adverb: *Come* IN. *He went* ABOUT *doing good. The boy jumped* DOWN.

A preposition is generally placed before its object. In ordinary constructions it precedes *whom*, *which* and *what*, but it may follow them. *That*, when used as a conjunctive pronoun, always precedes the preposition. *The lady* WITH WHOM *you sang went to the city. The lumber* OF WHICH *this house is built came* FROM MICHIGAN. *The boy* THAT *you spoke* TO *was my brother.*

Some prepositions are compound; as, *into*, *upon*, *within.* Some words which were originally present participles are now used as prepositions. These are, *touching*, *considering*, *regarding*, *respecting* and a few others. Some follow verbs; as, *laugh* AT, *carry* OFF, while others are combined with the verbs; as, UNDER-*go*, OVER-*take.* When a preposition is joined to a transitive verb it makes the meaning of the verb more exact. When joined to an intransitive verb it makes it transitive (see *The passive voice*, *Instruction Book II*, page 28).

The meaning of the prepositional phrase depends upon the preposition, hence care should be used in the selection

of prepositions. Do not use two prepositions in the same phrase, unless they are phrase-prepositions; as, *on account of*, *according to*. Say, *John fell* OFF *the roof*; not, *John fell* OFF OF, or, OFF FROM *the roof*. Say, To *whom shall we go*; not, To *whom shall we go* TO.

THE CONJUNCTION.

A conjunction is a word used to connect words, phrases and sentences; *Mary* AND *Nellie are students*. *The money was given him to keep* OR *to spend as he chose*. *Thomas is a merchant* BUT *Henry is a lawyer*.

A co-ordinate conjunction is one that connects words, phrases or sentences of equal rank: *The train arrived* AND *the boat sailed*.

There are four classes of co-ordinate conjunctions: copulative, disjunctive, adversative and illative.

A copulative conjunction is one expressing the idea of addition; as, *and*, *also*, *both*.

A disjunctive conjunction is one that expresses the idea of separation; as, *else*, *otherwise*, *either*, *or*, *neither*, *nor*.

An illative conjunction is one that expresses the idea of effect or consequence; as, *therefore*, *hence*, *so*, *so as*, *so that*.

A subordinate conjunction is one that connects a subordinate clause to the word which it modifies: *He said* THAT *he would go*.

The classes of subordinate conjunctions generally recognized are, (1) Time; as, *before*, *ere*, *since*, *after*, *as soon as*. (2) Reason or cause; as, *because*, *whereas*, *for*, *since*. (3) Supposition or condition; as, *if*, *except*, *provided*, and *otherwise*. (4) Comparison; *than*. The

comparative clause introduced by *than* is usually omitted. *John can skate better* THAN *I* (can skate). (5) Concession; *though*, *although*. (6) Purpose; *that*, *in order that*.

Correlatives are conjunctions used in pairs. They are so called because the former is always followed by the latter.

The principal correlatives are: *as-as*, *so-as*, *so-that*, *both-and*, *either-or*, *more-than*, *though-yet*, *not-only*, *but-also*, *such-as*, *the-the*, *neither-nor*, *whether-or*.

The following constructions should be kept in mind when using correlatives:

(1) *Such*, denoting comparison, should be followed by *as*: *This is not* SUCH *a house* AS *I wish to purchase*.

(2) *Such*, denoting cause or effect, should be followed by *that*: *My occupation is* SUCH THAT *I cannot spare time for study*.

(3) *Both* should be followed by *and*: *Both algebra* AND *geometry are excellent for discipline*.

(4) *Either* should be followed by *or*, and *neither* by *nor*: EITHER *this* OR *that book will be satisfactory*. NEITHER *Spain* NOR *Belgium is one of the great powers*. This rule is frequently violated.

(5) *Other* should be followed by *than*: *There is no* OTHER *means of crossing the river* THAN *that provided by the ferry*.

(6) Do not use *like* for *as* or *as though*. Say, *He looks* AS THOUGH *he had been sick*; not, *He looks* LIKE *he had been sick*. *You walk* AS *I do*; not, *You walk* LIKE *I do*.

OTHER CONNECTIVES.

The conjunctive pronoun and conjunctive adverb have already been referred to as performing the office of con-

nectives. They are subordinate conjunctives, but differ from the subordinate conjunction in that they perform the office of connective and also of a pronoun or adverb, as the case may be.

A conjunctive pronoun cannot be the subject or object of a simple sentence; it is employed to introduce a clause, and is either the subject or object of the verb in the clause introduced. *The man* WHO *came yesterday returned. The horse* WHICH *you showed me was sold.*

The conjunctive adverb modifies a verb, an adjective or another adverb in the clause which it introduces: *I was ready for the work* WHEN *the hour arrived. I saw the place* WHERE *the wreck occurred.* The words which stand in the relation of antecedents of conjunctive adverbs are seldom expressed; such as, THERE-*where*, THEN-*when.*

An interjection is a part of speech used to express sudden emotion or to call attention: ALAS, *what a fate is mine!* HURRAH *for the captain!*

Interjections are used to express pity, joy, laughter, contempt, silence and surprise; and for interrogating, saluting and parting. An interjection is always used independently.

THE SENTENCE.

A sentence is a group of words expressing a complete thought: *Fire burns. Snow is white.*

The elements of a sentence are the parts composing it. They are classed as principal, subordinate and independent.

The principal elements of a sentence are those which make the unqualified assertion; they are called subject and predicate.

The subject of a sentence is that about which something is said: WASHINGTON *was our first president.*

The predicate of a sentence is the part which tells something about the subject: *Boys* RUN. *Andrew* CAME.

The bare subject of a sentence may be:

(1) A noun or pronoun: *The* BOOK *is on the table.* HE *told me to meet him here.*

(2) A phrase: TO LOVE *is to live.* SMELTING IRON *is a dangerous occupation.*

(3) A clause: WHAT HE SAID *is true.* HOW THE FIRE STARTED *is not known.*

The bare predicate may be:

(1) A verb: *Jennie* SINGS *well.*

(2) A verb phrase: *I* SHALL RETURN *to-morrow. The horse* WAS STOLEN *yesterday. Our friends* COULD HAVE COME *on the boat.*

The subordinate elements of a sentence are those used as modifiers of the subject and predicate. According to their use they are classed as objective, adjective and adverbial elements; according to their form, as word, phrase and clause elements.

An objective element is one that is the object of the verb of the predicate: *William read the* BOOK.

An adjective element is one that modifies a noun or pronoun in the subject or predicate: *The* GREAT *waves of the sea broke against the* ROCKY *cliff.*

An adverbial element is one that modifies a verb, an adjective or another adverb in the sentence: *A* VERY *tall man was walking* SLOWLY *across the lawn.*

A word element consists of a single word: as, *man, pretty, run.*

A phrase element is a group of words not containing subject and predicate and used as part of speech: *The*

rays OF THE SUN *warm the earth.* *Grover Cleveland* WAS ELECTED *president.*

A clause element or *clause* is a subordinate element containing a subject and predicate and when used as an adjective or adverb is introduced by a conjunctive pronoun, a conjunctive adverb or a subordinate conjunction: WHAT WE DO *lives after us.* *God said*, "LET THERE BE LIGHT." *The man* WHO POSES AS MY FRIEND *may be false.* WHEN THE SUN RISES, *the mist disappears.*

Phrases and clauses perform the offices of parts of speech, and should be disposed of as such. If analyzed at all, the analysis should extend only so far as necessary to point out the relation of their own words to each other.

An independent element is one that has no grammatical relation to the other parts of the sentence: ROVER, *go home.* An element may be independent:

(1) By direct address: MR. PRESIDENT, *I wish to offer a resolution.*

(2) By exclamation: ALAS, POOR YORICK, *I knew him well!*

(3) By pleonasm: THY ROD AND THY STAFF, *they comfort me.*

(4) By absolute construction: THE STORM HAVING CEASED, *we proceeded on our journey.*

CLASSIFICATION OF SENTENCES.

According to their use, sentences are classified as declarative, interrogative, imperative and exclamatory.

A declarative sentence is one that states a fact: *The soul is immortal.* *Magellan sailed around the world.*

An interrogative sentence is one that asks a question:

Who is president of the United States? What shall it profit a man if he gain the whole world and lose his own soul? An interrogative sentence usually begins with an interrogative pronoun, an interrogative adjective, a conjunctive adverb, or an auxiliary verb. In the last case the auxiliary precedes the subject: WILL *you bring me the book?* An interrogative sentence should always be followed by an interrogation point.

An imperative sentence is one that expresses command, entreaty, or exhortation: *Love thy neighbor. Pity the sorrows of a poor old man. Do not yield to temptation.* An imperative sentence should be followed by a period. As noticed under the imperative mode, the subject of an imperative sentence is seldom expressed; it is understood to be *you* or *thou* for the singular, and *you* or *ye* for the plural.

According to their structure, sentences are simple, compound and complex.

A simple sentence is one that contains only one subject and predicate. In its simplest form the simple sentence contains only the bare subject and bare predicate: *Flowers blossom. Horses run.* This sentence can be extended by adding modifiers to both subject and predicate. EARLY *flowers blossom* IN THE SPRING. So long as the subordinate elements are words or phrases, the structure of the sentence is not changed, however much it may be extended.

A compound sentence is one that contains two or more sentences of equal rank. They are joined by a co-ordinate conjunction and are called *members. The sun shines and the birds sing. William came home and George went to the city.*

Authorities differ in their classification of simple and compound sentences. Some claim that a simple sentence may have either its subject or its predicate compound: NELLIE *and* EMMA *went to the city.* *Boys* RUN *and* JUMP. Others hold that a simple sentence can have only one subject and one predicate. These authorities would classify both the above sentences as compound, claiming that the full expression of the thought is *Nellie went to school and Emma went to school.* *Boys run and boys jump.* The first classification seems the more reasonable and is certainly in accord with good usage.

A complex sentence is one having one or more clauses for subordinate elements. The clauses may be a part of either the subject or predicate: *The boat* WHICH WAS LOADED WITH COAL *was lost.* *Life is a bubble* WHICH ANY BREATH MAY DISSOLVE.

Compose five complex sentences, making use of clauses in both subject and predicate, and send them in with your recitation paper.

EXERCISE.

(a) Find the prepositional phrases in the following sentences:

1. The rain beat against the windows.
2. An old man came slowly up the walk.
3. Will you return by boat?
4. The bridge over the river is made of iron.
5. We went to the city to attend the concert.
6. The audience listened intently to the speaker.
7. Mary came home to see her mother, but returned to school the next week.
8. All were there but him.
9. The child was lost among the crowd.

10. At midnight in the forest shades
Bozzaris ranged his Suliote band,
True as the steel of their tried blades,
Heroes in heart and hand.

—*Fitz-Greene Halleck.*

(b) Construct sentences in which each of the prepositions will be used correctly with the word that it follows:

1. Change, *into*, *for*, *to*.
2. Accountable, *to*, *for*.
3. Died, *of*, *from*, *with*.
4. Fought, *with*, *against*.
5. Live, *upon*, *at*, *in*, *on*.
6. Introduce, *to*, *into*.
7. Love, *of*, *to*, *for*.
8. Sympathize, *with*, *in*.
9. Divide, *among*, *between*.
10. Part, *from*, *with*.

(c) Find and classify the conjunctions in the following sentences:

1. The boy was punished because he was guilty.
2. I would pay you if I had the money.
3. The man was a hero, therefore he was honored.
4. Men may come and men may go, but I go on forever.
5. The speech was not eloquent, neither was it logical.
6. There were cloudbursts on the mountains, hence the valleys were flooded.
7. Do not trust him, for he will deceive you.
8. Such as I have, give I thee.
9. Any life that is worth living must be a struggle, a swimming, not with, but against, the stream.

—*Dean Stanley.*

10. Fire from the mind as vigor from the limb;
And life's enchanted cup but sparkles near the brim. —*Byron.*

For extra practice study the following selection for the purpose of applying all that you have learned in your study of the first three numbers of your course. Find:

(1) The subjects and predicates of the sentences.
(2) The prepositional phrases.
(3) The subordinate conjunctions.
(4) The infinitives.
(5) The adjectives and participles.

A PSALM OF LIFE.

Tell me not, in mournful numbers,
Life is but an empty dream.
For the soul is dead that slumbers,
And things are not what they seem.

Life is real; Life is earnest;
And the grave is not its goal;
Dust thou art, to dust returnest,
Was not spoken of the soul.

Not enjoyment, and not sorrow,
Is our destined end or way;
But to act, that each to-morrow
Find us farther than to-day.

Art is long, and Time is fleeting,
And our hearts though stout and brave,
Still, like muffled drums, are beating
Funeral marches to the grave.

In the world's broad field of battle,
In the bivouac of Life,
Be not like dumb, driven cattle!
Be a hero in the strife!

Trust no Future, howe'er pleasant!
Let the dead Past bury its dead!
Act,—act in the living Present!
Heart within, and God o'erhead!

Lives of great men all remind us
We can make our lives sublime,
And, departing, leave behind us
Footprints on the sands of time;—

Footprints, that perhaps another,
Sailing o'er life's solemn main,
A forlorn and shipwrecked brother,
Seeing, shall take heart again.

Let us, then, be up and doing,
With a heart for any fate;
Still achieving, still pursuing,
Learn to labor and to wait.

—*Longfellow.*

ENGLISH COMPOSITION

ENGLISH COMPOSITION.

SYNTAX OF SENTENCES (*Continued*).

Cautions. (15) Do not confuse the following words:

Shall and *will.* To express simple futurity, use *shall* in the first person and *will* in the second and third; as, *I* SHALL *be drowned; nobody* WILL *help me.* The sentence foretells an event which the speaker believes will happen. To express purpose, determination, a promise, obligation or inevitable action which the speaker means to control, use *will* in the first person and *shall* in the second and third; as, *I* WILL *be drowned; nobody* SHALL *help me.* (See *Instruction Book IX* p. 77.)

May and *can.* The word *may* expresses permission or probability; as, MAY *I speak with you a moment?*

Can denotes ability or power; as, CAN *you not speak distinctly?*

Sit and *set.* *Set* is a transitive verb and means to place in position. *Sit* is intransitive. *She* SET *there an hour*, is incorrect. Say, *She* SAT *there an hour* *She* SAT *the dish on the table*, is incorrect. Say, *She* SET *the dish on the table.* But *set* in some of its meanings is intransitive; as, *The sun* SETS *in the west;* and *The tide* SETS *in at two o'clock.*

Lie and *lay.* *Lie* is intransitive and means *to recline.* *Lay* is transitive and means *to put in position, to place.* *She* LAID *down for a nap*, is incorrect. Say, *She* LAY *down for a nap.* *He* LAY *the* BOOK *on the table*, is incorrect. Say, *He* LAID *the* BOOK *on the table.*

Fly, flee and *flow.* *Fly* means *to soar in the air;*

flee means *to escape; flow* means *to glide as a river. The children* FLEW *from the presence of their father*, is incorrect. The sentence should read, *The children* FLED *from the presence of their father. The doves* FLED *to their nests in the tower*, is incorrect. Say, *The doves* FLEW *to their nests in the tower. That river* HAS *often* OVERFLOWN *its banks*, is incorrect. Say, *That river* HAS *often* OVERFLOWED *its banks.*

To, *two* and *too*. *To* is a preposition and sign of the infinitive; *too* is an adverb. *You are* TO *good* TOO *me*, is incorrect. The correct usage is, *You are* TOO *good* TO *me. Two* is a numeral adjective; as, *My* TWO *sisters are at home.*

Like and *as*. In comparisons, use *like* when it means *similar* and may properly be followed by *to*. Use *as* when a verb follows in close connection. *Her eyes are* AS *stars*, should read, *Her eyes are* LIKE *stars. I wish I could sing* LIKE *you do*, is incorrect. Say, *I wish I could sing* AS *you do.*

Exercise 9. State a reason for the use of each italicized word in the following sentences: 1. You *may* hear from him by the next mail. 2. Go and *lie* down. 3. He has *lain* there an hour. 4. The old man was *fleeing* from justice. 5. He *shall* go, since you wish it so much. 6. Hear me, for I *will* speak. 7. I *shall* never see him again. 8. I *will* never see him again. 9 I think we *shall* have rain. 10. The old hen was *sitting* on her nest. 11. *Set* the plates on the table. 12. He *can* never accomplish all he has planned. 13. The robins have *flown* southward.

III. *The order of words* in a sentence is of great importance in determining the sense. The following

general principles will aid you greatly in arranging words in sentences:

I. "What is to be thought of first should be mentioned first."
II. "Things to be thought of together should be placed in close connection."—*Dr. Bain.*

The order of words varies according to the meaning of the sentence.

In a *statement of fact*, the usual order is (1) subject (including modifiers), (2) predicate (including modifiers); as, *The daisy's cheek is tipped with a blush.*

In a *question*, the subject (including modifiers) may follow the first word of the verb phrase; as, in the sentence, *Where was Washington Irving born?* The subject, *Washington Irving*, follows *was*, the first word of the verb phrase, *was born*. When an interrogative adjective or pronoun begins the sentence, the order may be the same as in a statement of fact; as, *Who assassinated Lincoln?*

In a *command*, the subject is usually omitted, and the sentence begins with the verb; as, *Give me a pledge of your sincerity.*

A word modifier of a noun usually precedes it; as, *The* AMERICAN *people are very progressive.*

A word modifier of a verb usually follows it; as, *Emma walks* SLOWLY.

A phrase or clause usually stands after the word it modifies; as, *The people* OF AMERICA *are very progressive;* and, *The workingmen* WHOM WE SAW *seemed contented.*

The object of a verb usually follows the verb which governs it; as, *Misers hoard their* GOLD.

The complement of an intransitive verb usually follows the verb; as, *The girl looked* PALE.

An adverb precedes an adjective or adverb which it modifies; as, *John was* EXCEEDINGLY *careless.*

Cautions. (1) A relative pronoun as object of a verb precedes the verb that governs it; as, *We greeted all* WHOM *we met.*

(2) Do not separate the preposition *to* from the verb in the infinitive. *To* BRAVELY *die*, is incorrect. Say, *To die* BRAVELY.

(3) Avoid separating a preposition from its object; as, *Brown was in favor* OF, *but all the others were opposed to the* MEASURE. Say, *Brown was in favor* OF *the* MEASURE, *but all the others were opposed to it.*

(4) When two words are used correlatively, each member of the pair should come before the same part of speech. *The clergyman* BOTH *spoke eloquently* AND *sincerely*, is incorrect. The correlatives in the sentence are *both* and *and.* The sentence should read, *The clergyman spoke* BOTH *eloquently* AND *sincerely.*

Exercise 10. Rearrange the following sentences, stating the reason for each change you make: 1. My friend bought a white pair of silk gloves. 2. It is impossible to continually be at work. 3. The pupils of some high schools are not only obliged to learn the German language, but to speak it. 4. Mr. Smith was kind to everybody whom he associated with. 5. Galloped up the hill the gallant commander. 6. Came into my heart a wonderful joy.

THE ESSENTIAL QUALITIES OF THE SENTENCE.

The essential qualities of the sentence are clearness, emphasis, unity and smoothness.

Clearness. The most important principle governing

the use of language is this: A sentence should be so constructed as to be understood with the least possible effort on the part of the reader or hearer.

Precautions for clearness. (1) Observe closely; listen attentively to what people say; think clearly before you speak or write; that is, have definitely in your own mind a complete thought before you speak or write a word. The following extract from a letter is a striking illustration of the kind of writing which results from lack of observation, attention and clear thinking:

"*At the lecture Wednesday evening—no, not at the lecture but at the theater—and it wasn't Wednesday evening but Tuesday, I believe—Mrs. Parker sat near me and told me that Mary Wilson had recently been married, or engaged, I'm not quite sure which.*" Had the writer of this sentence one definite thought in her mind? If so, what was her thought?

(2) Choose words which you are sure express exactly what you mean; *She* PERSUADED *him to go* means more than *She* ADVISED *him to go. Persuade* means *to advise with effect.*

(3) Discriminate carefully between words which are similar in meaning or sound; as, *healthful* and *healthy. The climate of Virginia is very* HEALTHY, is incorrect.

(4) Avoid all violations of the rules of syntax; as, *Did you ever think of* HIM SINGING?

(5) Exercise great care in the arrangement of words, phrases and clauses. (See *Syntax. The order of words.*) In the sentence, *The poor man was poisoned by eating salmon at a picnic that was put up in a tin can*, the arrangement is faulty.

(6) Do not attempt to make a grammatical connection

between words which are not connected in thought; as, BEING *the belle of the town*, HE *lost no time in making Miss McCarthy's acquaintance.*

(7) Repeat any word which is necessary to clearness. In the sentence, *I think he likes me better than you*, what word should be repeated to make the thought clear?

Exercise 11. Revise all the sentences given as illustrations under *Precautions for clearness.*

Revise the following sentences according to the *Precautions for clearness*, and state the reason for each change that you make: 1. The Americans nearly lost two thousand men in that battle. 2. All criminals are not guilty. 3. Fruit is very healthy in hot climates. 4. Wanted, a cook and seamstress. 5. The Emperor of Germany presented to the King of England a portrait of himself. 6. I was very much surprised at them coming. 7. Do you want opportunities? 8. She wore a diamond ornament in her hair which was bought in Paris. 9. A hat is a covering for the head without a brim.

Reproduce in your own words some short story which you have read. Revise it carefully, correcting all violations of the *Rules of syntax*, and of the *Precautions for clearness.*

DRAWING

DRAWING.

In all of the lessons of this number, do the best you can by depending on the eye alone. The tests are given to help you prove your drawings, but the eye must be trained first.

Hold a plain glass tumbler without decoration of any kind and if possible as large at the bottom as at the top, so that the rim at the top is on a level with the eye. Notice the shape. Hold it at arm's length with the top rim on the level of the shoulders so that you can see partly inside. What change has taken place in the appearance of the top rim? Of the bottom? Hold it at arm's length on a level with the waist. Notice the change in the appearance of the top and bottom. Does the lower edge appear to be straight or curved? Does it curve up or down? Does it curve more when below the level of the eye, than when on the level? Which ellipse representing the top or bottom would be wider from front to back? Follow this with experiments of a similar kind with the oak-tag cylinder. This illustrates the following principle or rule: The bases of a vertical cylinder appear horizontal ellipses and the nearer base always appears the narrower ellipse. In Figure 1, the top is narrower than the bottom; i. e., the line 1-2 is shorter than 3-4.

The long diameter of the ellipse representing any circle is perpendicular to a line which is at right angles to the circle at its center. In the cylinder this line is its axis, and in any drawing of the cylinder the long diameter of each ellipse must always be at right angles to the axis of the cylinder. In Figures 1, 2 and 3, the long

diameters 5-6 and 7-8 of the ellipses are at right angles to the axis a-b. Place the cylinder on the desk with its axis horizontal and at an angle so that the end and curved surface can be seen. Draw and compare with Figure 2. The drawing illustrates the following rules:

1. The bases of a cylinder appear ellipses whose long diameters are at right angles to the axis of the cylinder, the nearer base having the narrower ellipse. 5-6 and 7-8 are at right angles to a-b, and 1-2 is shorter than 3-4.

2. Vertical foreshortened circles below or above the level of the eye appear ellipses whose axes are not vertical lines. Figure 2. The lines 5-6 and 7-8 are not vertical lines.

3. The elements of the cylinder appear to converge in the direction of the invisible end. This convergence is never represented when the cylinder is vertical. In Figures 2 and 3, the lines 5-7 and 6-8 representing the elements converge toward the end 7-4-8-3.

Draw the cylinder when placed as in Figure 3 and note the following rule: When an end and the curved surface of a cylinder are seen at the same time, the end must appear an ellipse.

LESSONS.

Cone. Draw the cone first when the axis is vertical and second, when it is inclined. Notice that the appearance of the circle is the same as in the case of the cylinder and illustrates the rule: When the base of the cone appears an ellipse, the long diameter of the ellipse is at right angles to the axis of the cone. See Figures 4, 5 and 6.

Square Pyramid. Draw the pyramid when below the

Fig. 1

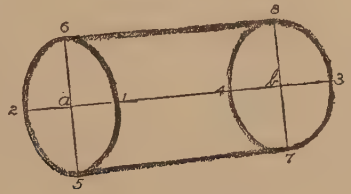


Fig. 2

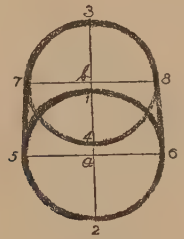


Fig. 3

Fig. 4

Fig. 5

Fig. 6

Fig. 7

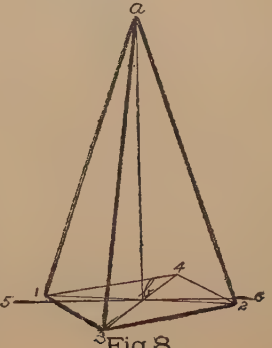


Fig. 8

eye; when the base is horizontal and one face is seen. Test the drawing by drawing the diagonals of the base and from the center erecting a vertical line, which should contain the vertex of the pyramid. Compare with Figure 7. Draw the pyramid when two sides are seen unequally; test the drawing by the axis, seeing if it is perpendicular to a horizontal line drawn through the center of the base. In Figure 8 the line 5-6 passes behind 2 and in front of 1, and is a horizontal line. When the pyramid is oblique as in Figure 9, the line 5-6 has the same relative position, passing in front of the farther angle of the base 1, and behind the nearer angle 2.

Equilateral Triangular Prism. Draw the prism when neither end of it can be seen. The long edges must be represented by parallel lines. See Figure 10. Notice the points d and c are in perpendiculars to the long edges, passing through the perspective centers 1 and 2 of the lower edges of the triangles.

Make a drawing when an end is seen with two sides which appear alike, and compare with Figure 11. Notice that the end b-d-f does not appear its real shape and is not an equilateral triangle. Draw the prism when an end and a side are seen. See Figure 12. The drawing may be tested by a vertical line through point d. This vertical should intersect b-f nearer f than b, for the nearer half of any retreating line appears longer than the farther half.

In the regular hexagon, Figure 13, the diagonal O-4 is divided into four equal parts by the diameters C-A and D-B and the diagonals C-B and A-D. A drawing of this form may be tested by seeing that the parallel lines vanish in the directions of their farther ends and that

Fig. 9

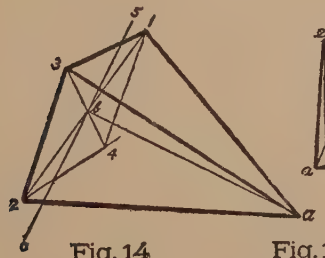


Fig. 10

Fig. 11

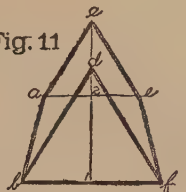


Fig. 12

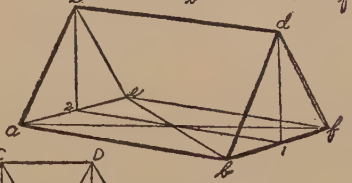


Fig. 13

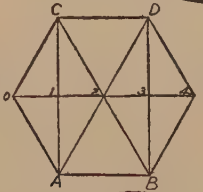
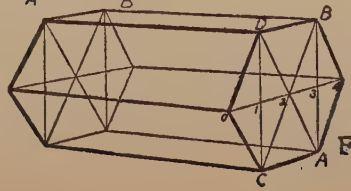


Fig. 14

Fig. 15

Fig. 16

Fig. 17



the diameters intersect the diagonal so that the points in it are perspectively equidistant. In the Figures 15, 16 and 17, the points O-1-2-3-4 are perspectively equidistant; that is, O-1 is a little longer than 3-4.

Hexagonal Prism. Draw the prism when it is vertical and two sides are seen equally. Compare with Figure 14. Draw the prism when three of its vertical faces are seen, the outer ones appearing of equal width. Compare with Figure 15. The edges A-B and C-D should appear perpendicular to the axis of the prism. Draw the prism when three faces appear of unequal width. Compare with Figure 16. Notice particularly that the parallel horizontal lines of the ends vanish in four points at the level of the eye. Draw the prism when horizontal and turned. Compare with Figure 17. The diameters of the end are vertical lines, D-C and B-A, and with the diagonals D-A and B-C give points 1-2-3-4, which are perspectively equidistant.

After learning to draw easily from a single model, it is well to begin grouping. If the picture of a group is desired, careful thought must be given to the arrangement, for if arranged in one way the group may be pleasing, while if arranged differently, the result may be wholly unsatisfactory. In studying the arrangement of a group, consider:

1. The place of the principal object. 2. The place of the secondary object. 3. The figure made by the group on the table. 4. A partial view of some of the objects. 5. The upper line of the group. 6. The variety in the position of the axes and in the faces visible. 7. The repose of the objects. 8. The unity of the group — distance between objects.

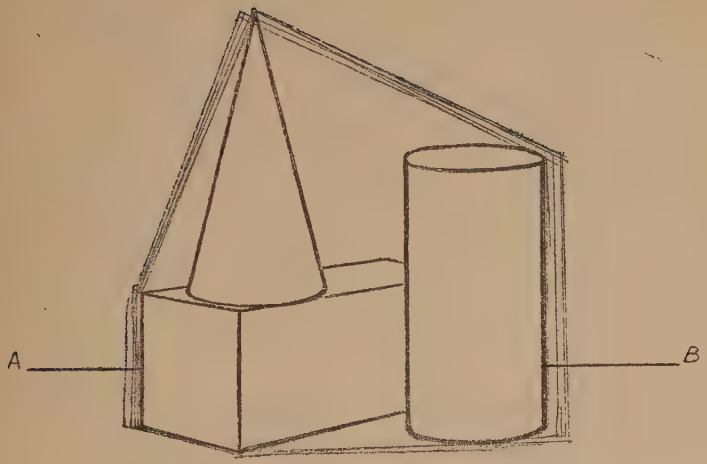


Fig. 18

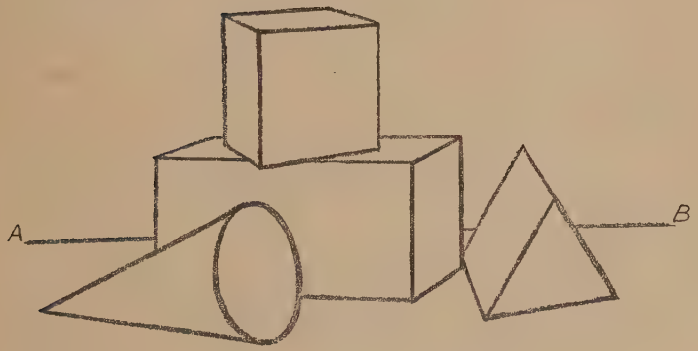


Fig. 19

(1) Choose the principal object and generally place it toward the center, not exactly in the center; (2) do not place the other objects in a straight line with the principal object; (3) try to arrange the objects so that if the centers of their bases were connected, an irregular figure would be made; (4) place them as if they belonged together, and so that they appear at rest. But remember that the objects should not have the same position; i. e., their axes should not be all vertical or all horizontal; they should not be parallel or at right angles to each other, and they should not show the same faces. One of the objects should be partially hidden behind another, even if there are only two in the group, and the objects should not appear of the same height when drawn. If one of the objects is placed so that its axis or its leading lines tend from you, it carries the eye into the distance; this is always pleasing.

Arrange a group with the square prism, the cone and the cylinder in it. Read over the suggestions about blocking-in in the second number of the course. Block-in the group.

In the beginning, you should understand that your drawings are of little value in themselves, and of use only as they train the eye to see correctly. The mind can be trained to accept the image of the eye only by depending upon it. If you begin by measuring and testing, the chances are that you will never be able to draw in any other way. Depending upon measurements is undesirable for many reasons, but principally because no measurements can ever equal a trained eye. Depend entirely for your first drawing upon the eye, but test the proportion of the blocking-in lines in the following way.

Hold the pencil out *at arm's length*, so as to appear

Fig. 20.

Fig. 21

to cover the dimensions of the object. Thus, if the top of a pencil when it is held at right angles to the direction in which the object is seen, is made to cover the highest point, and the lowest point is marked on the pencil by the thumb nail, the distance thus set off measures the apparent height of the object. If the pencil is now changed to a horizontal position, the apparent height may be compared with the apparent width by making the end of the pencil cover the left point of the object. If the height and width are the same, the thumb nail will appear to cover the right point. If the width is greater or less, the proportion can be readily seen. The shorter measurement should always be compared with the longer. The pencil must be at right angles to the direction in which the object is seen, thus the pencil is not vertical when the student looks above or below the level of the eye. Constant care is needed in making comparisons of this kind.

It is important that this use of the pencil should determine simply the proportion of the drawing, and not its real size. The measurements on the pencil should never be transferred to the paper, as they would often be too small. The great difficulty of using this test for measuring is in holding the pencil; but if the pencil is held so that the flat or unsharpened end is seen as a straight line, it must be about at right angles to the line of vision. When proportions are compared, the distance of the pencil from the eye must be the same. After rapidly blocking-in the group, correct the proportion by the test given above; make the outline; erase unnecessary lines, and finish. Study the gradations from light to dark gray lines in Figures 18 and 19. The line A–B is called the table line and helps to give a feeling of rest to the picture.

STUDIES.

Sprays. A lilac branch of strong, sturdy growth makes a beautiful exercise. Arrange the spray in a graceful position, making it look as lifelike as possible. It will remain fresh longer in water.

Draw the leading lines lightly and quickly, and block-in the entire branch. See Figure 20.

Compare with the spray. Notice how the upper leaves grow; the different directions they take in growing. Hold your pencil vertically between you and a leaf and note the direction of the leaf. Change the pencil to a horizontal position and compare it with the leaves to note their direction.

Where are the largest leaves? Which point upward and which to left and right? How many face you? Notice how seldom they exactly face you. Study the size and shape of the leaves and the thickness of the stem and twig. Change the blocking-in to curved lines and line in and accent.

Any other simple branch with simple leaves, as the cherry, pear, apple or peach, may be chosen for other exercises. Study Figure 21.

If any student should take this lesson on branches during the winter months, choose a branch from a potted plant. A geranium with not more than seven or eight leaves on it would be suitable. Primroses and cyclamen make very interesting and beautiful studies.

The studies on models may be made when they are above the eye instead of below the eye for the practice in drawing vanishing lines which converge downwards. Hold the model out at arm's length a few inches above the head,

and look steadily at it for a few minutes. Then lay aside and make the drawings. It is important to notice that retreating lines vanish downward; and curves, which curved upward when the object was below the eye, appear to curve downward when the curve is above the eye. Several Japanese lanterns, hung on a string above the eye will help you to see this principle and will make a valuable lesson from which to study cylinders above the eye. Boxes, valises, vases and rose jars can be placed on the corner of some object like a piano or cupboard and seen above the eye.

GEOGRAPHY

GEOGRAPHY.

THE UNITED STATES.

The United States extends from the Atlantic to the Pacific, and from British America to the Gulf. Its northern boundary is the 49th parallel for most of the way, and its southern limit is within one hundred miles of the Tropic of Cancer. Its area, including Alaska, the Philippine Islands, Hawaii, and Porto Rico, is 3,681,000 square miles. Without these it is 3,000,000 square miles. Its population is now (1900) about 78,000,000. This extent of territory includes a great variety of surface, climate, and other physical conditions. The extremes of heat and cold are worthy of notice. A small section of the southern coast line is in the torrid zone of temperature; in certain desert sections of the southwestern part of the country, and in some lowlands between mountain ranges, excessive heat is experienced during portions of the year. Winters in the north and central parts are quite cold. These conditions naturally divide the country into certain well-defined industrial sections. (1) See *Instruction Book IX*, pages 15 and 124.

(1) "Owing largely to differences in surface structure, climate, and soil, the great productions of our country are confined more or less definitely to different regions. Hence the United States may be naturally separated into (1) the Northeastern, or cloth-manufacturing section; (2) the Northern, or food-, iron-, and coal-producing and manufacturing section; (3) the Southern, or cotton-producing section; (4) the Plateau, or grazing, and gold- and silver-mining section; (5) the Pacific, or Western food- and gold-producing section."

—*Natural Advanced Geography.*

(1) The agricultural department at Washington profitably points out the error of trying to raise certain grains or fruits within areas not adapted to their growth.

In extent and value of her natural resources the United States leads the world.(2)

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(2) "The Appalachian highlands are rich in coal, iron, petroleum, and natural gas. Zinc, nickel, salt, and gold are obtained in paying quantities. Marble, slate, and building-stone are extensively quarried. * * * The Great Central Plain drained by the Mississippi and its branches forms the most important agricultural region of the world. The basin of this river-system is the greatest grain- and meat-producing region in the world, and is the source of much of the food supply of Europe, as well as the United States. * * * Cotton is the most valuable of our raw products. American cotton is superior to that of any other country. Cotton-seed is valuable for its oil, and the meal is extensively used for a fertilizer and for feeding stock. * * * The States of the Mississippi system raise nearly all the wheat exported. Russia and Austria-Hungary are the only great nations of Europe which raise more wheat than they consume. * * * Corn is the most extensive food crop grown in the country. The chief sources of supply are the States of the Mississippi valley. * * * Other important food products exported include domestic animals, dressed meat, and dairy products. Tobacco and lumber are also important articles of export. The leading mineral exports are iron ore, iron and steel, petroleum, copper, and silver. The coal production is second only to that of Great Britain. * * * The fisheries of the United States are more valuable than those of any other nation, and give employment to nearly 150,000 men. Massachusetts and Maine carry on one-half the general fisheries. New York, Maryland, and California have considerable fishing fleets. Most of the cod fishing is from Massachusetts. Oregon and Alaska are developing extensive salmon fisheries. The most extensive and important oyster beds in the world are in Chesapeake Bay. The oyster industry is Maryland's chief source of wealth. The beds cover about 120,000 acres, and the catch per year is 10,000,000 bushels, valued at $2,000,000."

— Adapted from Tilden's *Commercial Geography.*

(2) The United States produces one-fourth the cotton, one-fourth the wheat, four-fifths the corn, one-fourth the cattle, one-half the tobacco, one-half the hogs, one-fifth the fish, one-third the lumber, one-third the coal, one-fourth the iron ore, one-fourth the gold and silver and one-third the manufactures of the world, and carries on one-fourth the commerce.

The United States also leads all other nations in the extent and variety of her manufactures.(3)

The area of the United States and variety of natural conditions especially adapt the country to a large domestic commerce. Each industrial section excels in those productions for which it is best suited, consequently there is economy in the exchange of products.(4) The demands of this commerce have led to the construction of numerous waterways and railroads. (5) (Look up the leading canals and trunk lines of railways. See where they converge, and find the reasons.)

In her foreign commerce the United States ranks third among the great nations. Our foreign commerce has increased rapidly within the last few years, and for the fiscal year ending June 30, 1902, amounted to the enormous sum of $2,463,595,741. Of this amount, $983,574,456 were imports and $1,480,020,741 exports.

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(3) "Not only is the United States the greatest manufacturing country, but in extent and variety of manufactures it surpasses any other two countries of the world. Nearly every kind of article wanted by civilized man is made somewhere in our country, and nearly always it is made more cheaply here than anywhere else, for in no other country is there so much labor-saving machinery used as in the United States." —*Natural Advanced Geography.*

(4) "The collection of raw materials from various parts of the United States at the points of manufacture or export, the distribution of the manufactured products to the places where they are to be used or exported, and the importation and distribution of goods not produced in the country, give rise to a commerce greater than that of any other two nations in the world." —*Natural Advanced Geography.*

(5) "The railway mileage of the United States is greater than that of Europe. Railways have been built for commercial rather than military ends. Many trunk lines were extended into new and unsettled regions, in which towns and cities sprung up in great rapidity, and new States were soon formed." —Tilden.

Present indications are that our commerce with Asiatic nations, especially China, will be greatly increased within the next few years.(6) (Look up the nations with which this commerce is carried on, the products exchanged with each, and the ocean routes over which it travels.)

The great cities of a country depend upon the commercial and manufacturing facilities, or both, for their location and growth. In the United States these may be classified as seaports, lake ports, and river ports.(7)

Means of communication, including postal, telegraph, and telephone systems, railways, and canals, are fully developed, and among the best in the world.(8)

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(6) "In order of value the bulk of the import trade of the United States is carried on with Great Britain and her possessions, Germany, France, Spain, Brazil, Japan, Italy, The Netherlands, the Hawaiian Islands, Venezuela, Belgium, and Austria-Hungary.

"In order of value the export trade of the country is carried on with Great Britain, Germany, France, Belgium, The Netherlands, Spain, Italy, Russia, and Mexico." — Tilden's *Commercial Geography.*

"The acquisition of the Hawaiian Islands and the Philippines by the United States will greatly increase her trade in the ports of the Pacific. The exports and imports in this trade should be looked up

(7) The leading seaports in order of importance are New York, Boston, New Orleans, San Francisco, Philadelphia, and Baltimore.

The most important lake ports are Buffalo, Cleveland, Detroit, Chicago, and Duluth. The river ports are Memphis, St. Louis, St. Paul, Minneapolis, Kansas City, Omaha, Cincinnati, and Pittsburg.

(Trace the causes that have given these cities their location and present importance.)

Chicago is the most important lake port. More vessels clear yearly from this port than from New York and Philadelphia together. Chicago is also the largest railroad center in the world. Railways aggregating over 70,000 miles make this city their chief terminus.

(8) The United States has about two-thirds of a million miles of telegraph wire. The early construction of a cable connecting her with the Philippines is looked for. The country also has 350,000 miles of telephone wire, and over half a million telephones in operation.

STUDIES.

I.

1. Determine the latitude and longitude of the United States.

2. What other countries are within the same parallels of latitude?

3. Study the coast waters of:

(a) The Atlantic. (b) The Gulf. (c) The Pacific.

Notice the good harbors and be able to locate them.

4. Study the surface of the country under the following divisions:

(a) Atlantic Slope. (b) Atlantic Highlands. (c) Central Plain. (d) Pacific Highlands. (e) Pacific Slope.

II.

1. Navigable waters:

(a) Lakes.

(b) Rivers. { Atlantic system. / Mississippi system. / Lake system. / Pacific system.

2. Industrial sections. Trace on the map the boundaries of each as indicated in note 1 of the outline.

3. Learn what states lead in the production of:

(a) Coal.
(b) Petroleum.
(c) Iron.
(d) Copper.
(e) Gold and silver.
(f) Wheat.
(g) Corn.
(h) Cotton.
(i) Fruit.
(j) Lumber.

4. Name and locate the capitals of the different states.

5. Locate the great commercial centers named in note 7. What causes have led to their development?

III.

1. Name the states which lead in the manufacture or production of:

(a) Cotton and woolen goods. (b) Iron and steel products — machinery, rails, nails, etc. (c) Boots and shoes. (d) Dressed meat. (e) Sugar. (f) Salt.

Give reasons for the location of each of these industries.

2. Trace on the map the leading transcontinental lines of railway, and the most important canals. Notice the relation of these to the leading commercial and manufacturing centers.

3. Study the domestic commerce of the United States under these heads:

(a) Industrial sections.
(b) Natural products of each section.
(c) Extent of the country.
(d) Transportation facilities.

Study facilities for communication under the following heads:

(a) Postal system. (b) Telegraph. (c) Telephone.

IV.

Study Mexico, Central America and the West Indies, according to the plan given in *Instruction Book II*, page 68.

PHYSICAL GEOGRAPHY

PHYSICAL GEOGRAPHY.

CLIMATE; PLANT AND ANIMAL LIFE.

Every day there are changes in temperature, and perhaps also in wind direction, abundance of clouds, and dryness or dampness of the air. These changes from day to day are called changes in the *weather*. The term weather includes all the atmospheric conditions that an observer may feel or see,—hot or cold, clear or cloudy, dry or wet, windy or calm. Climate includes and averages these weather conditions. (1)

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(1) "The general succession of weather changes through the year, averaged for many years, constitutes the climate of a region. Thus we say that some places have a dry climate, others humid, some variable, others equable. The elements of the weather are wind, rain, clouds, sunshine, temperature changes, etc.; and the elements of climate are the same, except that less attention is paid to the *single* cases and more to the *general result*." Tarr's *Physical Geography*.

(1) "In the torrid zone the weather is marked by regular changes from day to night; the changes are small at sea and greater on land, and they are seldom interrupted by storms. In the summer of temperate latitudes the same is largely true, although hot and cold periods give variety to the regular succession of day-and-night changes." —Davis's *Physical Geography*.

(1) "On account of the great influence of extensive land or water surfaces upon variations of temperature, localities at which the annual temperature oscillates through a wide range are said to have a *continental* climate, while those where the range is small are said to have an *oceanic* climate." —Eclectic *Physical Geography*.

(1) "In general, the east side of continents in middle and higher latitudes has a continental climate with abnormally low mean temperature, and the greatest rainfall in summer; while the west side has a moderately oceanic climate with an abnormally high mean temperature, and the greatest rainfall in winter." —Eclectic *Physical Geography*.

(1) "The currents on the west side of all oceans move *from* the equator in tropical latitudes and are relatively warm, while on the east side of the tropical oceans currents move *toward* the equator and are

Near the equator there is a *belt of calms*, which is the place where the air is rising. This ascending air cools, some of its vapor is condensed, and rain storms are of daily occurrence. This is the zone where the midday sun stands nearly vertical at all times of the year, and it is therefore the warmest belt. (2)

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relatively cool. Hence the east coasts of the continents in *equatorial* regions have a warmer climate than west coasts."

— Eclectic *Physical Geography.*

(1) "Of all natural forces, the climate and rainfall are the most important, as an excess of cold or an absence of rain forbids the development of human activity."

— Channing's *Students' History United States.*

(1) "Modern scientific discoveries have only slightly affected other natural forces, as climate and rainfall. They have enabled man to make a better use of fertile soils and rich mineral deposits; they have also, by means of artificial irrigation converted barren valleys into fruitful gardens. As yet, however, science has not been able to increase the rainfall of a rainless region or to moderate the climate so far as to affect agriculture." — Channing's *Students' History United States.*

(2) "In this belt sailing vessels may linger for days, and even weeks, without having a wind of sufficient force to drive them through to the zone of the trade winds. On the ocean, where the doldrums are best developed, the air of both day and night is warm and humid throughout the year. The heat of the daytime, although great and oppressive, is tempered somewhat by the ocean, and this is the most equable climate in the world." — Tarr's *Physical Geography.*

(2) "There are many times more land north of the equator than south of it, and this land heats more readily than the ocean heats. From this it results that the hottest part of the earth is not just at the equator, as we might suppose, but six or seven hundred miles north of it." Werner's *Grammar School Geography.*

(2) "This is a rainy, relatively calm, and very warm belt. In it are situated the heavily forested rainy districts of central Africa and the Amazon valley. These change gradually to less dense forests on either side, and in Africa gradually give place to the dry desert of Sahara, on which almost no vegetation can grow."

— Tarr's *Physical Geography.*

There is much more variety in the climate of the *trade wind belt* than in the belt of calms. Being within the tropics, the temperature is everywhere high excepting on the lofty mountain tops, where the climate is almost frigid. (3)

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(2) "Just as the warm and moist climate of the equatorial forest and the frigid climate of Greenland are natural results of the form and rotation of the earth, so the dry climate of the Sahara is a natural result of the movements of the atmosphere on the rotating earth, warmed around the equator by a hot sun."

—Davis's *Physical Geography.*

(2) "As the belt of calms migrates with the seasons, the position of the heavy rain changes, so that on the margin of the tropical rain belt, there is a climate which is dry in one season and very wet in the other. This is shown in South America, where the llanos of Venezuela are rainy during the summer season, and dry in the winter, and also in the campos of Brazil, south of the equator, which are well watered in winter and dry in summer." Tarr's *Physical Geography.*

(3) "Among these mountains one may journey from the zone of perpetual summer, to that where the conditions of spring prevail throughout the year, and then, going still higher, one may rise above the elevation where timber can grow, and finally into a region where the nights are cold and the days cool, and perhaps even as cold as those of the northern winter." Tarr's *Physical Geography.*

(3) "Over the ocean the trade winds blow with wonderful steadiness, moving constantly, and with distinct strength in one direction. They are warm and carry much vapor, taken as they pass over the sea; but since they are blowing from colder to warmer latitudes, their temperature is constantly rising, and hence they are able to take much more vapor. Therefore as they blow over the sea, they do much work of evaporation, and here they are not especially rainy winds; but that the trade winds *are carrying* much vapor is proved by the fact that when the air has its temperature lowered, when rising in the belt of calms, it precipitates quantities of moisture." —Tarr's *Physical Geography.*

(3) "When blowing over the land, the trade winds may produce deserts as they do in the Sahara north of the equator, and in Australia and South Africa south of the equator. The desert climate is one of extreme heat in the day, followed by a cool, or in winter really cold, night. Because of the dryness of the air, which permits heat to readily

Very little is known about the climate of the south frigid belt. Within the Arctic circle there is a progressive increase in the severity of the climate as one proceeds northward. (4)

Near the frigid zones the temperate climate is quite like that near the Arctic and Antarctic circles; and near the tropics the conditions resemble those described for the trade wind belt. (5)

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reach the ground throughout the daytime, and allows it to be radiated at night with almost equal ease, the temperature range of the desert is great. As the name indicates, a desert climate is one of great dryness, rarely if ever a climate in which *no* rain falls, but one in which there is little precipitation, and this only in certain seasons."

— Tarr's *Physical Geography.*

(4) "In the winter the sun rises high enough to cause twilight at midday, and the night is therefore constant. Then there is a season of prevailing cold. After this comes the summer, when plants burst forth into blossom, and the hum of insects is heard, being warmed into life under the influence of the summer sun, that shines by night as well as by day. Though low in the heavens, the sun warms the earth, the frost disappears from the surface, and even at midnight the temperature does not descend to the freezing point. During this season rain may fall as far north as man has gone. After this comes the autumn, when the darkness of night again appears, and the earth, warmed slightly by day, cools at night, so that the bays begin to freeze, snow commences to fall, and gradually the day becomes shorter, until finally the winter night sets in, and for weeks, and further north even for months, the sun is not seen."

— Tarr's *Physical Geography.*

(5) "These two zones, one south and one north of the equator, are characterized by prevailing moderate temperature, changing from warm and perhaps hot in summer, to cool or cold conditions in winter."

— Tarr's *Physical Geography.*

(5) "The north temperate zone contains large areas of land and water, and the climates of its various parts are therefore very unlike. The parallel of 50° N. crosses regions whose climates are so different that they would hardly have been placed under a single zone had they been studied before being named. Beginning in the moderate climate

There are three great zones of life inhabited by different assemblages of animals and plants,— the ocean, the land, and the fresh water. In each of these there are sub-

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of the North Atlantic, the parallel of 50° N. enters the favorable climate of middle Europe, where the last thousand years have witnessed the greatest human progress in the arts and sciences that the world has ever known. It crosses the broad deserts of central Asia, where the scattered population is held down in barbarism chiefly by severe and unfavorable climatic conditions."

— Davis's *Physical Geography.*

(5) "Within this belt of variable temperate climate there is much variety from place to place. The great city of St. Petersburg is situated in nearly the same latitude as southern Greenland and northern Labrador,— places inhabited only by Esquimaux and a few Europeans who live there for purposes of trade; Berlin and London lie in the latitude of southern Labrador, a sparsely settled region, having a climate of almost Arctic rigor; and New York lies in the latitude of southern Italy and Greece, places with warm and almost subtropical climates."

— Tarr's *Physical Geography.*

(5) "There are two reasons for these conditions, one the fact that the prevailing westerlies blow over eastern America, after having passed across the land, while those of Europe have blown across the ocean water. The second reason is that the water of the eastern Atlantic, on the European coast, is warmed by an ocean current from the south (the Gulf Stream), while the American shores are bathed by a frigid current (the Labrador) from the icy Arctic sea. For similar reasons the western coast of the United States is warmer than the eastern, and also warmer than the eastern coast of Asia in the same latitude; but the difference between the climates of the Asiatic and American coasts is less than that just described, as no cold Arctic current bathes the shores of eastern Asia." — Tarr's *Physical Geography.*

(5) "There are also noticeable differences in the climate of the temperate zone according to altitude. In a small way this may be seen in any mountainous district, like that of New England, where the valleys are very much warmer than the mountain tops."

— Tarr's *Physical Geography.*

(5) "Again there is a variation in climate from the sea to the interior. The climate of New York City is warmer and more equable than that of Ohio, and this in turn is less extreme than that of Wyoming, yet all are in the same latitude." — Tarr's *Physical Geography.*

zones in which the animals and plants differ because of variations in temperature. (6)

In the sea both plants and animals exist in great abundance, though the latter greatly exceed the former in importance. Excepting at the very coast line, none of the higher flowering plants, so common on the land, are found. In the sea the plant life belongs to the lower forms of vegetation, notably the seaweed. The great expanse of ocean bottom, where the water is deep, is devoid of vegetable life, being in this respect a great desert extending over nearly three-fourths of the earth's surface.

The deep ocean floors have no plants. They are inhabited by a considerable variety of animals, such as fish, crabs, shellfish, starfish, etc.; but the forms of life are here much less varied and less numerous than in the shallower waters near the shore. (7)

(5) "These same differences in climate are shown near lakes, as for instance along the shores of Lake Erie, in western New York. Here the conditions are so equable, near the lake shore, that an extensive grape-raising industry has developed, while upon the hillsides, two or three miles away, this industry is not possible."

— Tarr's *Physical Geography.*

(6) "For instance, there are very different organisms in the tropical belt from those of the frigid or even the temperate zone, and this applies to ocean and fresh-water as well as to land animals. Besides these there are other zones in the sea and deeper lakes, for the nature of the flora and fauna varies with depth. Also in the larger bodies of water there are changes with distance from shore, and also along the shore, as the nature of the coast varies. There are also numerous subdivisions of the zones of land life. The creatures that live among the mountains differ from those of the plain, while those of the humid seacoast climate bear very little resemblance to those of the desert."

— Tarr's *Physical Geography.*

(7) "The abundance of animal life in the sea is marvelous, and there is no part of its surface or bed which is not inhabited. We may recognize three great zones of animal life in the ocean: The *littoral*, or that of the seacoast; the *abyssal*, or that of the ocean bottom; and the *pelagic*, or that of the surface." — Tarr's *Physical Geography.*

The land surface, unless too cold, too dry, or too bare of rock waste (soil), is well covered with vegetation, the larger part of which consists of flowering plants, much more highly organized than the plants of the sea. (8) See *Instruction Book IX.* page 61.

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(7) "The surface layers of the open ocean possess a considerable variety of animal life, from large mammals like whales to minute organisms whose tiny shells are so plentifully strewn over the ocean floor." —Davis's *Physical Geography.*

(7) "The intermediate depths of the ocean, between the upper part and the bottom, are prevailingly without life — a great desert space, cold, quiet, and monotonous." —Davis's *Physical Geography.*

(7) "The shallow waters of the ocean margin teem with plants and animals. Many animals, such as sponges, corals, and barnacles, are fixed to the bottom; they need not move about in search for food, because the moving waters bring it to them. Nearly all the plants of the sea are of a comparatively simple kind, without flowers or seeds. The shallow waters are the fishing grounds of the sea, and furnish important supplies of food to the neighboring lands." —Davis's *Physical Geography.*

(8) "The most characteristic life on the land is the plant life, and yet animals are of very high importance. Vegetation clothes the surface almost everywhere, furnishing dwelling-places for many animals and supplying all with food. Animals of the land have not the power of taking food directly from the earth; but plants are able to convert earthy materials into substance which animals can use; even those creatures which do not take their food directly from plants, do so more indirectly from other animals." —Tarr's *Physical Geography.*

(8) "Plants that need a plentiful rainfall cannot spread into those regions in which the winds fail to supply rain, even if the temperature is fitting. Thus corn, which grows so luxuriantly in the Ohio and middle Mississippi valleys, cannot be raised on the dry western plains without the aid of irrigation. On the other hand, many kinds of thorny cactus plants are found on the plains; but they cannot invade the moister regions further east."—Davis's *Physical Geography.*

(8) "Within the Arctic regions the willows and other species of trees creep along the ground, raising their leaves and flowers no higher than is necessary; for early in the winter it is vitally important to secure a covering of snow which shall protect them from the intense cold." —Tarr's *Physical Geography.*

Land animals are numerous, varied, and as a whole highly organized. They exceed the animals of the deep sea floor in variety of structure and habit. They are exceeded in number by the animals of the shallow sea margins or of the open sea surface. (9)

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(8) "The temperature of a country determines its agricultural produce; thus Indian corn demands a good deal of heat, while cotton will not thrive without a greater intensity of heat. Corn, furthermore, is peculiarly sensitive to frosts, and will not mature where they occur early in the autumn. Apples will thrive in a region where the winters are severe, but one touch of frost destroys years of growth of an orange grove." — Channing's *Students' History United States.*

(8) "Of equal importance is the amount and distribution of moisture. If the rainfall is excessive, the cotton plant, for example, makes a rank growth, or becomes so choked with weeds that it will not grow at all; but if it does not have abundant moisture, it will not thrive. Corn, on the other hand, absorbs moisture from the air, and will grow in seasons of drought, when other plants inevitably perish."
— Channing's *Students' History United States.*

(8) "In the scale of existence plants occupy a position intermediate between minerals and animals. Plants take from the soil and elaborate into food, the elements which animals require for their growth. Animals are, therefore, dependent on plants for their existence."
— Houston's *Physical Geography.*

(9) "Land animals, like plants, tend to spread over all parts of the earth to which they have access; the limits of their distribution are controlled partly by climate and partly by food supply, which in turn depends on climate. Like plants, animals are limited, on the polar side of their range chiefly by insufficient heat in summer, and on the equatorial side by excessive heat in summer. Within the belt thus defined by the values of summer temperatures the distribution of animals is largely controlled by food supply." — Davis's *Physical Geography.*

(9) "Without serious study one can hardly realize how closely dependent upon geographic conditions has the development of the human race been, although now we have nearly risen above this dependence. In his advance toward a higher civilization, man has been subjected to many of the same influences that have effected the abundance and variety of plants and animals." — Tarr's *Physical Geography.*

STUDIES.

I.

1. What makes the wind blow?

2. When a heavy snow falls early in the season you have noticed that the ground does not freeze. Does the snow keep the frost out of the ground or does it keep the heat in?

II.

1. The weather bureau predicts on Tuesday a violent storm for a certain locality on Wednesday afternoon; telegraphic communication is maintained with all points to estimate closely speed and direction of the storm center. If it is directly over Omaha Tuesday at 9:00 P. M., and has been moving 30 miles an hour northeast by east, what sections would be warned to expect it Wednesday afternoon?

2. Why would mountains, large bodies of water or opposing storm centers change in any respect the forecast?

III.

1. The British Isles lie almost wholly north of Newfoundland, and have the mild temperature of the central United States. Iceland, touching the Arctic Circle, nearly 20° north of Newfoundland, has the temperature of the Lake Superior region. Account for these facts and trace other unusual climatic conditions.

IV.

1. The entire system of plants native to any region constitutes the Flora of that region. What name is applied to its animal life?

2. Why is it that regions producing the most abundant vegetation are distinguished by extraordinary development of animal life?

PHYSIOLOGY AND HYGIENE

PHYSIOLOGY AND HYGIENE.

Nature has provided an intricate arrangement of tubes to conduct food to each cell of the body, and to wash away its waste matter. About one-thirteenth of the body is a red liquid called *blood.* (1) It consists of a multitude of circular flat red plates, called the *red blood corpuscles*, floating in a colorless liquid, which also contains a few round colorless cells, called *white blood corpuscles.* (2)

The liquid part of the blood is called the *plasma.* It is composed of ninety parts of water, holding in solution about eight parts of albumin and two parts of mineral

(1) "All the tissues of the body depend upon the blood for their nourishment. It is evident then that this vital fluid must be continually renewed, else it would speedily lose all of its life-giving material. Some provision, then, is necessary not only to have the blood renewed in quantity and quality, but also to enable it to carry away impurities." —Blaisdell's *Practical Physiology.*

(2) "The red corpuscles of the blood form about forty-five per cent of its weight. Each one is a circular flat plate, with rounded edges, and with a depression in the center of each face. *Hemoglobin* is the essential part of the red corpuscle. It contains a small amount of iron, which gives to it the property of carrying oxygen without itself being oxidized. By means of the hemoglobin the red corpuscles are able to carry oxygen from the lungs to all parts of the body. When the hemoglobin contains a large amount of oxygen the blood is of a bright red color, but as the oxygen is used up it becomes darker, or almost purple. Bright red blood, called *arterial* blood, is continually flowing toward the cells of the body; while that returning from the cells, called *venous* blood, is purple in color, from the lack of oxygen." —Overton's *Applied Physiology.*

(2) "White corpuscles are round and colorless, and each contains a nucleus. They have important duties to perform in preventing foreign substances from entering the circulation and in the healing of wounds." —Overton's *Applied Physiology.*

matter. The mineral matter is mostly soda and potash. This alkaline property of the blood plasma enables it to dissolve carbonic acid gas, and to carry it to the lungs, where it is breathed out from the body. Some of the mineral matter of the blood enters into the composition of the cells of the body, especially of bone cells.

When blood is drawn from the body it soon becomes a jellylike mass, called a *clot*. After a long time the clot becomes firmer and smaller, squeezing out a clear, straw-colored liquid, called *serum*. The process of changing blood from a liquid to a jellylike form is *coagulation*, or *clotting*. In the process a part of the albumin becomes solidified in small interlacing strings, called *fibrin*, which entangles the rest of the blood into its meshes. (3)

The temperature of the blood in health is about 100° F.; that of the body, 98.6° F. The blood constitutes about one-thirteenth of the total weight of the body, and in a person weighing 156 pounds would amount to about 12 pounds. The blood is kept flowing through all parts of the body by the action of the heart, assisted by the arteries and capillaries. The vessels leading from the heart and gradually growing smaller and smaller are the *arteries*. The very minute vessels into which they are at last subdivided are *capillaries*. The vessels which convey the blood back to the heart are the *veins*. Thus, the

(3) "This power of coagulation is of the most vital importance. But for this, a very small cut might cause bleeding sufficient to empty the blood-vessels, and death would speedily follow."

—Blaisdell's *Practical Physiology*.

(3) "For many years attempts have been made to inject healthy blood into the veins of sick persons. Injecting a liquid into the veins of a living person is *transfusion*. In bleeding, the loss of water is one of the greatest dangers, and to replace it water is sometimes injected into the veins. It answers better than blood itself."

—Overton's *Applied Physiology*.

arteries end in the tissues in fine, hair-like vessels, the capillaries; and the veins begin in the tissues in exceedingly small tubes,— the capillaries. There is no break in the continuity between the arteries and the veins, except in the spleen. The apparatus of circulation is thus formed by the *heart*, the *arteries*, the *capillaries*, and the *veins*. The left side of the heart pumps blood through the whole body, while its right side pumps it only through the lungs. (4)

Blood enters each auricle through tubes called *veins*, and streams through the opening in the ventricle, but is prevented from flowing back by thin, strong curtains called valves, which are attached to the edge of the opening and hang suspended in the ventricle. (5)

The tubes which conduct the blood away from the heart are called *arteries*. (6)

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(4) "The heart is a hollow organ, but the cavity is divided into two parts by a muscular partition forming a left and a right side, between which there is no communication. These two cavities are each divided by a horizontal partition into an upper and a lower chamber. These partitions, however, include a set of valves which open like folding doors between the two rooms. If these doors are closed there are two separate rooms, but if open there is practically only one room. The heart thus has four chambers, two on each side. The two upper chambers are called *auricles* from their supposed resemblance to the ear. The two lower chambers are called *ventricles*, and their walls form the chief portion of the muscular substance of the organ. There are, therefore, the right and left auricles, with their thin, soft walls, and the right and left ventricles, with their thick and strong walls."

—Blaisdell's *Practical Physiology*.

(5) "The heart is a valvular pump, which works on mechanical principles, the motive power being supplied by the contraction of its muscular fibers. Regarding the heart as a pump, its *valves* assume great importance."

—Blaisdell's *Practical Physiology*.

(6) It must be noted that the *pulmonary artery* carries *venous* blood from the right ventricle to the lungs, and that the four *pulmonary veins* carry *arterial* blood from the lungs to the left auricle.

The flow of blood in the arteries is caused by the muscular force of the heart, aided by the elastic tissues and muscular fibers of the arterial walls and to a certain extent by the muscles themselves. (7)

The blood in a capillary is separated from a living cell of the body by a wall so thin that it is no hindrance to the passage of oxygen from the red blood cells. (8)

Pressure direct upon the artery between a wound and the heart will often stop the flow of blood. It may sometimes be possible to tie a handkerchief very tightly around the limb between the wound and the heart. The

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(7) "In making a complete circuit of the body the blood passes through the *left auricle*, and through the *mitral valve* to the *left ventricle;* then past the *left semilunar valve* to the *aorta*, and then through the *arteries* to all parts of the body; then through the *capillaries* into the *veins*, and back to the heart; next through the *right auricle*, then the *right ventricle*, then through the *pulmonary artery* to the *capillaries* of the *lung*; then through the *pulmonary veins* to the *left auricle* once more. Thus in making the complete circuit of the body, a drop of blood passes through the heart twice, and through *two* different sets of capillaries. The circuit of the body in general is called the *systemic circulation*, and that through the lungs is the *pulmonary circulation.*" —Overton's *Applied Physiology.*

(8) "In return for the oxygen received from the blood, the body cells give out carbonic acid gas, which passes through the capillary walls into the blood as readily as the oxygen passes in the opposite direction. A given particle of blood remains in a capillary only a second at most, and in that time there occurs an exchange of oxygen and nutritive matter between the blood and the body cells. Arteries are simply tubes which conduct blood to the capillaries, where all the actual work of nourishing the cells is performed." —Overton's *Applied Physiology.*

(8) "The heart is not nourished by the blood which passes through it. The muscular substance of the heart itself is supplied with nourishment by two little arteries called the *coronary arteries*, which start from the aorta just above two of the semilunar valves. The blood is returned to the right auricle by the *coronary vein.*"

—Blaisdell's *Practical Physiology.*

knot in the handkerchief should lie over the artery, and if necessary a stick may be inserted under the band and twisted tightly enough to prevent the loss of blood until the surgeon arrives to take charge of the case.

Alcoholic drinks exercise a destructive influence upon the heart, the circulation, and the blood itself. The first effect of alcohol is to increase the force and frequency of the heart beats. But alcohol takes oxygen from the heart cells as well as from the other cells of the body and is likely to make the heart weaker.

When any alcohol is present in the circulation its greed for water induces the absorption of moisture from the red globules of the blood, the oxygen carriers. Thus, step by step, the use of alcoholics impairs the functions of the blood corpuscles, perverts nutrition, and slowly poisons the blood. (9)

While tobacco poisons more or less every organ of the body, it is upon the *heart* that it works its most serious wrong. Upon this most important organ its destructive effect is to depress and paralyze. Especially does this apply to the young, whose bodies are not yet knit into the vigor that can brave invasion. (10)

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(9) "The habitual use of alcohol produces a deleterious influence. The digestive powers are weakened, the appetite is impaired, and the muscular system is enfeebled." —Dr. Austin Flint, Sr.

(10) "Tobacco used in any form is a direct poison to the heart's muscle and causes it to beat with less strength. When a large amount is used, it poisons the nerves of the heart and hinders their harmonious action." —Overton's *Applied Physiology.*

(10) "I never smoke, because I have seen the most efficient proofs of the injurious effects of tobacco on the nervous system."
—Dr. Brown-Sequard.

STUDIES.

I.

1. Blood: (a) Plasma. (b) Red blood corpuscles. (c) White blood corpuscles.

2. Relative number of red and white corpuscles.

3. If a person weighing 130 lbs. loses 2 lbs. of blood how much has he left?

4. Plasma: (a) Color. (b) Composition. (c) Reaction.

II.

1. Clot: (a) Fibrin. (b) Fibrinogen. (c) Serum.

2. What is transfusion?

3. Study the heart. Examine the heart of an animal. Note the relative thickness of the right and left sides. Compare the auricles and ventricles as to the size, structure, and thickness of walls. Study the valves.

III.

1. Trace blood through the systemic circulation: (a) To the foot and back. (b) To the brain and back. (c) To the hand and back. Study the pulmonary circulation.

2. Obtain parts of an artery and of a vein for examination. Note condition of lumen. Compare the walls.

3. How does the cell get its food from the blood? How does the cell get rid of waste products?

4. Compare the rate of flow of blood in the arteries, veins, and capillaries.

5. How is the heart muscle supplied with blood?

6. How is the heart assisted in the circulation of the blood?

7. Where should a bandage be applied to stop severe bleeding from an artery? How determine whether bleeding is from an artery or from a vein?

IV.

1. Alcohol, influence upon: (a) The heart. (b) Arteries and veins. (c) Capillaries. (d) The blood.

2. Study the effects of tobacco upon the heart.

3. Count your pulse while lying down, while sitting, while standing, after exertion.

4. Examine the body over the heart and describe what you see, feel, and hear.

5. What is tobacco heart? Fatty heart?

6. Spleen: anatomy, size, shape, structure, location, function.

7. Bone marrow: color, composition, functions.

8. Anæmia: cause, symptoms, cure.

9. Blood poisoning. Auto-intoxication. Tetanus.

10. Give functions of white corpuscles. Of red corpuscles.

11. By what means does blood carry oxygen? Iron? Carbon dioxide?

HISTORY OF THE UNITED STATES

HISTORY OF THE UNITED STATES.

THE STRUGGLE FOR INDEPENDENCE.

The causes which resulted in the independence of the American colonies may be classed under two heads; commercial (1) and political (2). The first began with the

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(1) The Navigation Acts extended through a period of a century. The first class restricted commerce (a) By forbidding the colonies to carry on trade with any nation except England, and requiring all exports to be carried in English or colonial vessels. (b) Requiring all imports to be brought from England. (c) Imposing duties on goods exported from one colony to another. The second class restricted manufactures by (a) Limiting the number of apprentices taken by hatmakers, and prohibiting the exportation of hats. (b) Placing duties on rum and molasses imported from any but the British West Indies. (This is known as the Molasses Act.) (c) Prohibiting the erection of mills for the manufacture of steel and iron; also prohibiting exportation of woolen goods from one colony to another. It is needless to say that these laws were not strictly obeyed by the colonists.

(2) At the accession of George III there were three political parties in England; the Tories, the Old Whigs, and the New Whigs. Each of these parties found followers in the colonies. The king wanted to increase his power, and the Tories were his supporters. The Old Whigs stood for government by Parliament as it then existed. The franchise was very much restricted, and no change in the plan of electing members to the House of Commons had been made since the days of Cromwell. In consequence of this many representatives obtained their seats by direct purchase, as some burroughs represented were wholly depopulated, while large cities, like Manchester, were deprived of representation entirely. This condition of affairs threw the government into the hands of the aristocracy. It was claimed that the people were represented by classes instead of by districts. On this basis, Parliament claimed later that the colonies had representation. The New Whigs constituted a rapidly growing party who thought that the basis of representation should be entirely changed, and that the government should be taken out of the hands of the aristocracy. The attitude of the king toward these parties, and his attempt to use the American colonies as a tool in playing them off against each other for his personal advancement, had much to do with hastening the war.

Navigation Acts, the first of which was enacted as early as 1651. The second originated in the early attempts of the king to extend his authority over local matters in America through the prerogatives of royal governors. The merits of the question were not wholly one sided, but the colonists had by far the stronger cause. (3)

Several organizations were formed in the colonies to enable them to unite in resisting British aggression. (4) There were also a number of preliminary hostile acts by both parties. (5)

The Continental Congress should receive careful attention. It was the first national representative body in America, and its influence was at first very powerful. It organized the continental army, gave us the Declaration

(3) The following points were sustained by Parliament: (*a*) The great cost of the French and Indian War. (*b*) The high rate of taxation at home. (*c*) The authority of Parliament over the colonies. (*d*) No country had ever allowed its colonies representation in the home government. (*e*) The proposed rate of taxation was very light.

The colonies claimed in their favor: (*a*) The resolution of the first House of Commons in 1265. A tax on the colonies would repeal this resolution. (*b*) The colonies had paid much more than half the expenses of the war in America. (*c*) The Navigation Acts had greatly crippled the commerce of the colonies and caused them much hardship. (*d*) The attempt of the king to use his colonies in an unfair manner for his personal advancement was exasperating in the extreme.

(4) These organizations were: 1, Non-Importation Societies; 2, Sons of Liberty; 3, Committees of Correspondence; 4, Minute Men; 5, Colonial Militia; 6, Massachusetts Town Meeting; 7, Continental Congress.

(5) The hostile acts of the British were: 1, Stamp Act; 2, writs of assistance; 3, Declaration Act; 4, quartering of troops; 5, sending troops to Boston; 6, Boston massacre; 7, Boston Port Bill.

On the part of the colonies they were: 1, Treatment of customs officers; 2, opposition to writs of assistance; 3, destruction of tea; 4, treatment of the Tories; 5, organization of militia companies: 6. battle of Concord and Lexington.

of Independence, the Articles of Confederation, and, later, the Ordinance of 1787.

In connection with the preliminary events you should become familiar with the biographies of the leaders. (6) You should also become acquainted with these poems. (7)

Make a careful study of the campaigns. Note the purpose for which the campaign was planned; what it accomplished directly; its relation to the war as a whole. (8) Become also familiar with the plan and results of the important battles. (9)

The Declaration of Independence was the first great work of the Continental Congress. The Declaration should be carefully read. Notice particularly that it is

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(6) Look up especially the following: Samuel Adams, James Otis, Franklin, John Adams, Patrick Henry, Jefferson, Washington.

(7) "Paul Revere's Ride" (Longfellow), the "Concord Ode" (Emerson), "Grandmother's Story of the Battle of Bunker Hill" (Holmes), "The Boston Tea Party" (Holmes), the "Rising of '76" (Reed).

(8) The first study better be made by years. The review should be made by grouping the campaigns in the following order: 1, New England and Canada; 2, the struggle for the center, including all the movements of the armies in New York, New Jersey, and Pennsylvania; 3, the invasion from the north, Burgoyne's campaign; 4, the campaigns in the South. The battles to be especially remembered are Concord and Lexington, Bunker Hill, Trenton, Princeton, Saratoga and those connected with it, and Yorktown.

(9) "The moral effect of the battle of Bunker Hill, both in America and Europe, was remarkable. It was for the British a decided and important victory, inasmuch as they not only gained the ground for which the battle was fought, but by so doing they succeeded in keeping their hold upon Boston for nine months longer. Nevertheless, the moral advantage was felt to be with the Americans. It was they who were elated by the day's work, while it was the British who were dispirited. The belief that the Americans could not fight was that day dispelled forever." —Fiske's *American Revolution.*

not directed against the people of England, but against the king. We must never forget that the Revolutionary War was primarily a struggle for a political principle, and that the Americans had as warm supporters in England as they did in America, but their enemies had control of the government. (10) Read Henty's *True to The Old Flag.*

At the close of the war the United States gained all they asked in the treaty. (11) Financially the country was bankrupt. (12) Her commerce and industries were nearly ruined, but the people had gained their independence, and were hopeful of a prosperous future; they, however, had many difficult problems to solve. (13)

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(10) During the early part of the war when Boston was in a state of siege, business men in England subscribed a large sum of money for the relief of their American mercantile friends.

(11) "When the final treaty was signed at Paris, Sept. 3, 1783, it fully recognized all that we claimed, namely: 1, the independence of the American Republic; 2, the Mississippi River as the western boundary; 3, our right to fish on the banks of Newfoundland."

—Montgomery's *Student's American History.*

(12) "The summer of 1780 was the gloomiest time of the war. Because Congress could not tax the people, and could not get enough money from the states by asking for it, there was great difficulty in carrying on the war. Some money was borrowed from France and Holland, Congress was also obliged to issue its notes, or promises to pay. It is probable that during the Revolutionary War, more damage was done by paper currency than by all other causes put together. In the summer of 1780 it became worthless. It took $150 in Continental currency to buy a bushel of corn, and an ordinary suit of clothes cost $2,000." —Fiske's *History of the United States.*

(13) "The United States were now independent, but the problems which confronted the American people were no less arduous of solution than the securing of their independence had been. The stress of war had failed to unite them into a nation; would the time of peace be more fortunate? In a circular letter to the state governors (June, 1783) Washington adverted to these fears in language which showed him to be not merely a military leader but a statesman as well."

— Channing's *Students' History.*

STUDIES.

I.

Causes of the Revolutionary war.

Study each topic in the histories at your disposal:

1. Remote causes: (a) Navigation Acts (see note 1). (b) Political situation in England (note 2). (c) Financial condition of English government. (d) Great expense on account of the French and Indian war, and the necessity of guarding the extensive frontier in America.

2. Immediate causes: (a) Stamp Act. (b) Resistance by colonies (see note 3). (c) Stamp Act congress. (d) Acts of Parliament following repeal of the Stamp Act. (e) Organizations in America. These last are named in note 4. You should look up the origin and purpose of each.

II.

1. Preliminary hostile acts: (a) On the part of the British. (b) On the part of the Americans. Study each of these as found in note 5, and notice what bearing it had on bringing on the war.

III.

1. Campaigns and battles. Trace each campaign on the map, note the important battles connected with it, and the results: (a) Battle of Bunker Hill. (b) Ticonderoga and Quebec. (c) Siege of Boston, Washington appointed commander. (d) Operations around New York. (e) Trenton and Princeton. (f) Operations around Philadelphia. (g) Burgoyne's expedition, note the effect in Europe of his surrender. (h) Valley Forge. (i) Greene's campaign in the south. (j) Naval victory of John Paul Jones. (k) Surrender of Cornwallis.

IV.

1. Civil measures during the war. Make a careful study of each: (a) Continental congress, organization, duties. (b) Declaration of Independence. (c) Articles of Confederation. (d) Financial measures.

2. The treaty: (a) By what persons negotiated. (b) Terms.

3. Condition of the country at the close of the war. (a) Finances. (b) Agriculture. (c) Manufactures. (d) Commerce. (e) State jealousies, weakness of congress.

The above directions refer to the most important events only; if you have time it will strengthen your grasp on the subject to trace the career of several of the leading men through the war, particularly Washington, Greene, Stark, Schuyler, Gates Lafayette, Steuben, Benedict Arnold, Morgan.

CIVIL GOVERNMENT

CIVIL GOVERNMENT.

THE NATIONAL GOVERNMENT.

The constitutional convention. This convention was called to meet in the old state house at Philadelphia on May 14, 1787, but enough delegates did not arrive to admit of organization until May 25. On account of the large number of eminent men which it contained and the work which it did, the constitutional convention will always rank as one of the most important political assemblies of the world. (See *Government in State and Nation*, page 125.) All states except Rhode Island were represented, though some of the states were not in full sympathy with the movement. The convention was organized by the election of George Washington as president and William Jackson as secretary. It held its sessions with closed doors, and all of its records were kept secret. Fortunately James Madison took full shorthand notes of all of its proceedings and debates. Years afterward these were published under the title of *The Madison Papers*.

This convention was authorized to revise the articles of confederation. Its members soon found that such a revision could not possibly form a government that would be adequate to the needs of a Union. They therefore determined to proceed on an entirely new plan, and the result of this determination was the constitution of the United States as it now exists, without amendments. This work, great as it was, was completed in a comparatively short time, and the convention adjourned September 17, 1787. The following comparison will enable you to

understand the most vital points of difference between the constitution and the articles of confederation.

THE CONSTITUTION.	THE ARTICLES OF CONFEDERATION.
1. The constitution provides a national government based more or less on the will of the people.	1. The articles pledged a league of the states.
2. Representation in the lower house of congress is based upon the population of the state. Each state has two senators. Each member of congress has one vote.	2. Congress consisted of only one branch; each state, whatever its number of delegates, had only one vote.
3. The supreme court has jurisdiction over all disputes between states.	3. Congress decided disputes between states.
4. No state is allowed to coin and issue money.	4. Congress shared with the states the power to coin and issue money.
5. The power to regulate commerce and raise revenue is vested in the national government.	5. The power to regulate commerce and raise revenue was wholly under the control of the states.
6. Congress has power to declare war and to raise and maintain an army and navy. If necessary it can draft men for this purpose.	6. Congress could declare war, but the power to raise troops was within the control of the states.
7. Congress now has power to levy and collect taxes.	7. Congress could not collect taxes from the states.
8. Congress can authorize and execute all laws necessary for carrying into execution the powers conferred upon it.	8. Congress could not compel the observance of laws.
9. Congress has power to guarantee the payment of loans contracted by the United States.	9. The payment of borrowed money could not be guaranteed.
10. The constitution has been found adequate to every emergency that has arisen.	10. "Congress could declare everything but could do nothing."—Judge Story.

THE CONSTITUTION.

The constitution provides for a government having three distinct and coördinate departments: the legislative department, the executive department and the judicial department. The relations of these departments to one another and of the national government to the states are set forth in seven articles. When the constitution was given to the people and its provisions became known it met with violent opposition in many of the states. The discussion of the question of its adoption gave rise to the first two political parties of national scope, the Federalists and anti-Federalists.

In the following lessons those portions of the constitution which embrace its working clauses are quoted in full or in part. But in addition to this you should have at hand the complete document to which you can refer as you desire. The analysis on page 110 will enable you to get a pretty clear idea of the plan.

I. *The enacting clause.* We, the people of the United States, in order to form a more perfect union, establish justice, insure domestic tranquility, provide for the common defense, promote the general welfare, and secure the blessings of liberty to ourselves and our posterity, do ordain and establish this constitution for the United States of America.

The enacting clause in the constitution is very generally known as the preamble, which is really a preface to a set of resolutions.

The first statement, *We, the people of the United States*, is important, since it shows that the constitution was established by the people, thus making the United States a federal government and not a league of states.

Write out, in the order in which they are given, the reasons for establishing the constitution.

If you have a copy of the constitution of your state, compare the enacting clauses of the two documents. In what respects are they alike? In what do they differ?

ARTICLE I. THE LEGISLATIVE DEPARTMENT.

Section I. Congress. All legislative powers herein granted shall be vested in a congress of the United States, which shall consist of a senate and house of representatives.

The legislative department is the most important and is given more space in the constitution than either of the others. The two houses are the result of a compromise between the large and the small states. The first plan presented to the convention provided for a congress of only one branch. It also provided for representation on the basis of population. The small states objected so strenuously to this that the present plan was suggested as a way out of the difficulty. This gives the states equal representation in the senate, and a representation in the house in proportion to population. The plan was taken from the state government of Connecticut. A bicameral system is considered better, because legislation by a congress of two branches is never so hasty as that which passes only one body. Undoubtedly this plan has prevented a great deal of hasty and unwise legislation.

ARTICLE I.

SECTION II. THE HOUSE OF REPRESENTATIVES.

Clause 1. Composition and term. The house of representatives shall be composed of members chosen every second year by the people of the several states, and the electors in each state shall have the qualifications requi-

site for electors of the most numerous branch of the state legislature.

Legally the term of a representative begins at noon on March 4 following his election, but practically it does not begin until the first Monday in December, unless the president calls an extra session of congress.

The term for which representatives are elected determines the length of a congress. Each congress is known by its number, as the fifty-seventh congress. Each congress must hold two regular sessions and as many extra sessions as the president may see fit to call. The regular sessions begin on the first Monday in December. The first of these is called the long session, because it may extend through the summer, but it must end before the first of December of the year following its assembly. The second is called the short session, because it must end by noon on the 4th of March following its assembly.

Representatives are elected by the qualified voters of the state. Any one who can vote for a representative in the state legislature can vote for members of the house of representatives in congress. The qualifications of voters are determined by each state. (See Instruction Book II, page107.)

Clause 2. Qualifications. No person shall be a representative who shall not have attained the age of twenty-five years, and been seven years a citizen of the United States, and who shall not, when elected, be an inhabitant of that state in which he shall be chosen.

In all states, for business and voting purposes, a man becomes of age at twenty-one. It was thought that he needed at least four years of practical experience to enable him to discharge the duties of a representative; therefore the age limit was fixed at twenty-five years.

All persons born or naturalized in the United States and subject to the jurisdiction thereof and of the state wherein they reside are citizens of the United States. Amendment XIV, Section 1.

A representative must be an inhabitant. This means that he must be one who has a legal residence in the state; that is, he must be a permanent resident. This provision excludes those who reside in a state temporarily from becoming eligible to the house of representatives. While a representative is required to be an inhabitant of the state, the constitution does not require him to be an inhabitant of the district from which he is elected. In a few instances representatives have been chosen for districts in which they did not reside, but custom has made residence in the district practically a requisite to election.

Those who can not be representatives. 1. Those holding any office in the United States. See Article I, Section 6, Clause 2, of the constitution.

2. Those who, by engaging in rebellion against the United States, have violated their oath to support the constitution. This disability may be removed by congress. See Amendment XIV, Section 3.

What are the qualifications for representatives to your state legislature?

Who can vote in your state?

Clause 3. Apportionment. Representatives and direct taxes shall be apportioned among the several states which may be included within this Union, according to their respective numbers. . . . The actual enumeration shall be made within three years after the first meeting of the congress of the United States, and within every subsequent term of ten years, in such manner as they

shall by law direct. . . . The number of representatives shall not exceed one for every thirty thousand, but each state shall have at least one representative. Read Section 2, Amendment XIV.

The apportionment of representatives caused the convention more trouble than anything else that was brought before it. The small states were jealous of their rights and wanted equal representation with the large, while the large states wanted representation in proportion to their population. The slave-holding states wanted their slaves counted the same as other inhabitants in determining the basis of representation, while the states in which there was practically no slavery stoutly objected to this arrangement. The result of these conflicting claims was a compromise by which it was agreed to speak in the constitution of the slaves as *persons*, and to consider five slaves as equal to three free inhabitants in making the basis of representation. This gave the southern states a decided advantage, as without this arrangement their number of representatives would have been considerably lessened.

The abolition of slavery, which was provided for by Amendment XIII, rendered the three-fifths rule void, and all the colored population had to be counted in determining the basis of representation in the former slave states. See Amendment XIV, Section 2.

At the time of the constitutional convention the population of the United States was not known. The first congress met in 1789, and in 1790 the first census was taken. The census has been taken once every ten years since.

At first the rate of apportionment was one representa-

tive to every 30,000 inhabitants. This ratio has been changed at the taking of each census, being increased in proportion to the increase in population, until now it is one representative to every 194,182 inhabitants. The first house of representatives contained 65 members; the next will contain 386 members. Each state is guaranteed one representative. Otherwise many of the smaller states would now be without representation. When a new state is admitted, its representatives are added to the number provided for in the last apportionment.

For the purpose of electing representatives the states are divided by the state legislatures into congressional districts. These districts are required by law to be of contiguous territory and to contain as nearly as possible the number of inhabitants allotted one representative. Whenever by a new apportionment the number of representatives in any state is increased, these additional representatives may be chosen by the state instead of by districts, until new districts can be formed. When so chosen they are known as *representatives at large*.

Gerrymandering is the name given the redistricting a state for political purposes. When this is done the boundaries of the districts are so placed as to give the party in control of the state government a majority of the representatives in congress. Sometimes the districts are very irregular and their formation is unjust to the inhabitants.

Clause 4. Vacancies. When vacancies happen in the representation from any state, the executive authority thereof shall issue writs of election to fill such vacancies.

Vacancies are caused by death, resignation, the election of ineligible persons and by expulsion. Whenever a vacancy occurs, the governor of the state must appoint

a time when the voters of the district in which the vacancy occurs shall meet and elect a new representative for the remainder of the unexpired term.

Clause 5. House powers. The house of representatives shall choose their speaker and other officers; and shall have the sole power of impeachment.

The title of the presiding officer is derived from that of the presiding officer of the English house of commons, and is known as speaker. He is chosen by ballot from the members of the house. He holds his office during one congress and may be re-elected. The speaker's duties are prescribed by the rules of the house. By virtue of these rules the speaker is one of the most influential officers in the government. His most important duty is the appointment of the committees in the house of representatives. Each of these committees has charge of certain branches of legislation, and by the make-up of the committee the speaker can largely determine the legislation of the house of representatives during his term of office. He is also chairman of the committee on rules and is expected to preside over the sessions of the house when he is present.

The other officers are clerk, sergeant-at-arms, doorkeeper, postmaster and chaplain. None of these is a member of the house, but they are all elected by a vote of the house. Each of these officers has numerous assistants. The clerk's term of office does not expire until the election of the speaker in the succeeding congress, and it is his duty to call the house to order and preside until the speaker is elected.

Impeachment is a formal accusation in writing, charging some public officer with crime or with misdemeanor.

GENERAL OUTLINE OF THE CONSTITUTION.

Enacting clause, also reasons for the formation of the Constitution.

ARTICLE I. *Legislative Department.*

Sec. 1. Vestment of power in a congress of two houses.
Sec. 2. House of Representatives: apportionment, qualifications, election, term, sole powers.
Sec. 3. Senate: apportionment, qualifications, election, term, sole powers.
Sec. 4. Congress: time and place of election, time of meeting.
Sec. 5. Houses respectively: relations to members.
Sec. 6. Provisions common: privileges and disabilities.
Sec. 7. Mode of passing laws.
Sec. 8. Powers of congress.
Sec. 9. Prohibitions on congress.
Sec. 10. Prohibitions on the states.

ARTICLE II. *Executive Department.*

Sec. 1. Vestment of power, term, qualifications, election.
Sec. 2. Powers.
Sec. 3. Duties.
Sec. 4. Responsibility.

ARTICLE III. *Judicial Department.*

Sec. 1. Vestment of authority, appointment, term.
Sec. 2. Jurisdiction.
Sec. 3. Treason: definition, procedure.

ARTICLE IV. *The States.*

Sec. 1. Mutual credit of official papers.
Sec. 2. Interstate relations.
Sec. 3. New states and territories.
Sec. 4. Republican form of government guaranteed.

ARTICLE V. *Mode of Amending the Constitution.*

ARTICLE VI. *Miscellaneous.*

ARTICLE VII. *Ratification.*

AMENDMENTS.

1–10. Personal rights guaranteed.
11. Limitation on jurisdiction of U. S. courts.
12. Mode of electing president and vice-president.
13–15. Fruits of the Civil war.

BOOKKEEPING

BOOKKEEPING.

The purpose of bookkeeping is twofold. First, it affords a systematic record of the various steps taken in business transactions which are begun at one time and completed at another. Second, it is the principal source of information for determining the success or failure of a business enterprise. Incidentally, it furnishes a means for detecting and correcting mistakes and forestalls the making of many errors.

The personal accounts which you have completed illustrate the way in which bookkeeping shows the various steps in business transactions which are not begun and completed at one time. These accounts also show some of the many complications arising from some business customs of to-day which it would be very difficult to untangle if it were not for bookkeeping.

The second purpose of bookkeeping, viz., the supplying of the principal source of information for determining the degree of success or failure of a business enterprise, can be illustrated in only a meager way at this point. A full appreciation of the perfection of the art in this respect can only be had from a thorough understanding of double entry bookkeeping, which begins with the fifth number of this course.

In bookkeeping, that which furnishes the facts for determining the degree of success or failure of a business enterprise is called a statement.

A statement is a formal writing which sets forth the

resources and liabilities of the business, the present worth or insolvency, former worth or insolvency and the net gain or net loss.

Resources are things of value or those things which can produce value; as cash, property and debts due the firm.

Liabilities are the things which at some future time will cost or consume value; as promissory notes and other debts of the firm.

The present worth of a firm or individual is the amount which such firm or individual is worth at this time—the excess of resources over liabilities.

The insolvency of a firm or individual is the excess of liabilities over resources.

The former worth is the worth of the firm or individual at the beginning of a business enterprise; or the worth at the beginning of some definite period in the existence of the business enterprise, such period usually being one year, six months or three months.

The net gain is the excess of the present worth over the former worth, or the excess of the former insolvency over the present insolvency.

The net loss is the excess of the former worth over the present worth, or the excess of the present insolvency over the former insolvency.

STATEMENTS.

Prepare statements from the facts set forth in the following exercises. It will be advisable to put each statement upon loose journal paper first, because it may be difficult to determine whether a given statement is going

to show a net gain or loss, a present worth or insolvency.

I

On April 1, 190—, the books of A. P. Bender showed the following debit and credit balances: L. K. Ramsey, Dr., $320.18; A. B. Richmond, Dr., $1,230; D. M. Backus, Dr., $647.38; W. P. Stanford, Dr., $869.40; F. T. Rose, Dr., $933.80; cash on hand, $10,849.70; N. C. Stafford, Cr., $235.87; F. G. Kenney, Cr., $900.50; T. C. Long, Cr., $123.85. The former worth of Mr. Bender, on January 1, was $13,218.06. Find his present worth and net gain or loss.

STATEMENT OF A. P. BENDER, APRIL 1, 190–.

RESOURCES.			
L. K. Ramsey, Dr.	320 18		
A. B. Richmond, Dr.	1230		
D. M. Backus, Dr.	647 38		
W. P. Stanford, Dr.	869 40		
F. T. Rose, Dr.	933 80		
Cash on hand	10849 70	14850	46
LIABILITIES.			
N. C. Stafford, Cr.	235 87		
F. G. Kenney, Cr.	900 50		
F. C. Long, Cr.	123 85	1260	22
*Present Worth		13590	24
Present Worth		13590	24
Former Worth		13218	06
*Net Gain		372	18

*These entire lines must be written with red ink.

In the foregoing statement, the resources are given first, because they are greater than the liabilities. If the total liabilities exceeded the total resources, they would be given first. The former worth is written beneath the present worth because it is the smaller number and is to be subtracted from the present worth to determine the net gain. When the present worth is the smaller, it is written below the former worth so that the subtraction may be shown.

The present worth, insolvency, net loss and net gain should always be written in red ink. This is done for the sake of bringing out prominently the special points for which the statement is prepared.

Place this statement on the next blank page of the Journal-Ledger.

II

On June 30, 190–, J. McManus found upon his books the following open accounts: J. B. Smith, Dr., $243.96; L. M. Carson, Dr., $115.60; J. W. Judge, Dr., $402.93; E. R. Stockton, Dr., $807.32; C. W. Pierce, Dr., $87.25; John Sloan, Dr., $286.75; L. Sherwood, Dr., $525.15; cash on hand, $2,603.97; W. F. Finaling, Cr., $376.82; C. A. Benton, Cr., $250; M. A. Hide, Cr., $56.25; two notes, the first for $300 in favor of N. A. Brockman, and the second for $210, in favor of C. A. O'Connor. Make one entry of the last two items under the title, *notes payable*. On the last day of the preceding December, his worth was $2,976.59. Find his present worth and net gain or loss.

III

On January 1, 190—, G. A. Seipp began business with a cash investment of $8,238.72. On July 1 of the

same year, he had a stock of merchandise, the inventory value of which was $5,273.65 (enter this as *merchandise inventory*); his books showed the following open personal accounts: L. D. Baker, Dr., $155.72; F. R. Prieve, Cr., $654.35; E. N. Lill, Cr., $287.62; M. C. Carnahan, Dr., $325.15; I. C. Martin, Dr., $60.45; J. E. Cooper, Cr., $618.78; S. F. Langford, Cr., $785.32; John Noblow, Dr., $430.26; D. S. Reading, Dr., $532.45; C. H. Dietrich, Cr., $264.04; A. L. Horn, Dr., $843.24. He had cash on hand and in bank amounting to $2,308.46. Find his present worth and net gain or loss, on July 1.

IV

On January 1, 190–, the total resources of E. L. Zimmermann & Co. were $22.387.92, and the total liabilities were $28,563.75. On December 31 of that year, their books exhibited the following resources and liabilities: Inventory of merchandise on hand, $21,761.18; J. M. Hamilton, Dr., $1,892.48; B. Anderson, Cr., $4,317.45; P. S. Stevens, Cr., $7,209.06; B. C. Cramer, Dr., $963.28; H. H. Woodward, Dr., $1,068.92; M. E. Ryan, Dr., $462.39; E. W. Mead, Cr., $3,844.22; M. K. Farmington, Cr., $2,463.29; three promissory notes in favor of the First National Bank, for $5,000, $6,250, and $3,700, respectively. The firm has $4,746.31 cash on hand. What was the present worth or insolvency and net gain or loss of the firm on December 31?

V

The insolvency of E. E. Hagerson, on April 1, was $352.87. On June 30, his books showed the following resources and liabilities: merchandise on hand, $2,263.90; E. J. Dunfee, Dr., $26.73; C. S. Smith, Dr., $4.28;

J. P. Johnson, Dr., $109.62; F. S. Olsen, Dr., $54.63; J. A. Ames, Dr., $28.82; L. M. Jones, Dr., $70.08; Jas. Whitcomb, Cr., $348.20; Reynolds Bros., Cr., $118.56; P. A. Kelly, Cr., $872.90; one note for $1,000 due the Citizens' State Bank (enter this as *notes payable*); cash on hand, $210.25. Find his worth or insolvency on June 30, and also his net loss or net gain.

VI

On December 31, a statement prepared for Henry M. Scott exhibited the following items: merchandise inventory, $4,362.70; cash on hand, $1,732.45; Jackson Bros., Cr., $280.65. On the 30th of the following June, the inventory value of his merchandise was $4,871.25; cash on hand, $2,826.35; he owed the following persons: H. Davis, on account, $516.13; L. B. Hines, on account, $735.91; Frank Moore, on account, $256.25. Find his worth on June 30, and the net gain or loss for the period from December 31 to June 30.

VII

On July 1, 190—, the worth of W. W. Dunn was $547.53, as shown by a statement prepared at that time. On the 31st of the following December, he had a stock of merchandise worth $2,407.73; cash, $231.28; and the following personal accounts on his ledger (both the debit and credit footings are given and the student is required to find the balance): James Benson, Dr., $612.35, Cr., $150; T. C. Jack & Co., Dr., $604.81, Cr., $225; Neuman & Co., Dr., $400, Cr., $1,087.22; Smith & Wilson, Dr., $375, Cr., $830.39; Crescent Feed Co., Dr., $851.58, Cr., $250; Chas. Lee & Co., Dr., $209.54, Cr., $317.61; Brook & Son, Dr., $172.45, Cr., $758.68;

T. M. Willis, Dr., $100, Cr., $421.81; T. O. Pert, Dr., $539.45, Cr., $187.26. He owed his father $3,000, which was evidenced by two promissory notes for $2,000 and $1,000, respectively. What was his worth on December 31, and what was his net gain or loss?

PROPRIETOR'S ACCOUNT.

The proprietor's is another kind of personal account that is both like and unlike the ordinary personal accounts. It is like other personal accounts in that it represents what the business owes the proprietor or what the proprietor owes the business. It is credited for whatever value the proprietor gives to the business and debited for whatever value he takes from it. It is unlike other personal accounts in that it is credited for the net gain of the business or debited for the net loss; it is unlike other personal accounts in that it represents a creditor of the business with whom a settlement will not be effected, in a final closing, until all other creditors have been paid.

In the following exercises credit the proprietor's account for whatever values he puts into the business, and for the net gain. Debit the proprietor's account for all values withdrawn and the net loss, if any.

I

On April 1, 190—, H. P. Walton invested $4,500 in the grocery business.

April 18, he withdrew $250.

June 10, he added $1,200 to his investment.

June 30, the first quarterly statement showed a gain of $410.86, with which his account should be credited.

Close the account and bring down the present worth as shown in the form on the next page.

July 25, he withdrew $125

September 10, he withdrew $160.

The statement for the quarter ending September 30, showed a net loss of $84.26, with which his account should be debited. Close the account and bring down the present worth.

October 20, he made an additional investment of $1,000.

December 1, he added $500 to his investment.

The statement for the quarter ending December 31, showed a net gain of $503.93. Close the account and bring down the present worth.

H. P. WALTON, STK.

190—							
April	1		Cr. by net investment			4500	
	18		Withdrawal	250			
June	10		Cr. by additional investment			1200	
	30		Cr. by net gain			410	86
			*Present Worth	5860	86		
				6110	86	6110	86
July	1		Present Worth			5860	86
	25		Withdrawal	125			
Sept.	10		Withdrawal	160			
	30		Net loss	84	26		
			*Present Worth	5491	60		
				5860	86	5860	86
Oct.	1		Present Worth			5491	60
	20		Cr. by additional investment			1000	
Dec.	1		Cr. by additional investment			500	
	31		Cr. by net gain			503	93
			*Present Worth	7495	53		
				7495	53	7495	53
190—							
Jan.	1		Present Worth			7495	53

*These entire lines must be written with red ink.

II

E. C. Layton bought a stock of groceries on September 25 from G. A. Keats, giving a promissory note in payment for it. He put $100 cash into the business.

December 20 he withdrew $30 for personal use and his statement on December 31 showed a net loss of $85.22. Find his present worth or insolvency on Jan. 1.

Review the definition of present insolvency on page 114. Note that subtractions are never performed in book accounts; only additions are used. Note also that if a closing, red-ink entry is placed in the debit column, it is brought down in black ink in the credit column, while if the closing entry is in the credit column in red ink, it must be placed in the debit column when brought down.

III

On January 1, 190–, P. T. Goldsworth decided to open a new set of books because those he had been keeping were not in as satisfactory shape as he wished to have them. At that time he had a stock of merchandise, the inventory value of which was $2,153.26; cash on hand, $347.26; the other resources of the business exceeded the liabilities by $427.32. (Enter the aggregate amount of these items as the present worth or investment.)

February 15, he was obliged to pay a security debt of $241.75, and withdrew that amount in order to pay it.

April 8, he withdrew $65.

May 1, he withdrew $86.25.

June 15, he received $830 by inheritance and immediately invested it in his business.

On June 30, a statement of the success of his business for the past six months showed a net gain of $713.28. Close the account and bring down the present worth.

August 18, he withdrew $85.25.

October 3, he withdrew $105.75.

November 30, he withdrew $208.65.

The net gain for the six months ending December 31 was $801.72. What was his present worth on the first of the following January?

IV

J. M. C. Coate and H. M. Root formed a partnership on May 5, 190—. Mr. Coate invested cash $4,500, and Mr. Root invested a stock of merchandise valued at $3,862.37 and enough cash to make his investment equal that of his partner. Separate accounts must be kept for each partner and each must be credited for his investments and debited for withdrawals. Where partners share equally in the gains or losses, their investments should remain practically the same. Usually a personal account is kept for each partner in addition to his stock account. In this exercise only the stock accounts need be kept.

June 30, each partner withdrew $225.

October 15, Mr. Coate increased his investment $800 and Mr. Root did likewise on the 24th of the same month.

A statement prepared on December 31 showed their net gain to be $1,438.14. Half of this amount is to be credited to each partner.

Close their accounts and bring down the present worth of each.

On the 20th of the following July each withdrew $500.

November 12, each withdrew $275.

The net gain on December 31 was $1,622.74. Close the accounts and bring down the present worth of each.

PEDAGOGICS AND METHODS

PEDAGOGICS AND METHODS.

THE TEACHER.

MOTTO.

The inspiration of the school is the presence of the living teacher.

PRINCIPLES.

I. "In the last analysis, the vital element in teaching is the teacher. He is the soul of his methods and measures. If he is weak, they will be weak; if he is potent, they will be potent." —White.

II. "Above all, a teacher must be a scholar, and if he is to be a teacher of real power, he must be a man of wide and accurate scholarship." —Payne.

III. "The teacher must be one whose feelings are sensitive, strong, and in healthful equipoise. A man without a heart has no business to be a schoolmaster."
—Morgan.

IV. These five things characterize a good teacher—character, knowledge, enthusiasm, sympathy, and common-sense.

"It is the man who takes in who can give out. The man who does not do the one soon takes to spinning his own fancies out of his interior, like a spider, and he snares himself at last as well as his victims."
—Dr. John Brown.

The teaching power is almost in exact proportion to the growth of the teacher in knowledge. The teacher who acquires nothing has but little to give, and that little is quickly exhausted.

"The price of retaining what we know is always to seek to know more. We preserve our learning and mental power only by increasing them." —Henry Darling.

Character—The personal character of a teacher stands first in the test of qualifications. *Integrity* in all *business* transactions; a rigid *compliance* with the terms of *contract;* the conscientious discharge of every duty; freedom from all vices; a due regard to the potent influence of *example* over the lives of the children under his care; a high toned morality which cannot endure *anything base* or *low*,—these are some of the points which school directors cannot *scrutinize too closely* in persons who desire to act as teachers in the schools. The teacher should keep in mind the issues which hang upon his work. He must himself be all which he desires his pupils to become. In addition to the above, cleanliness of person, neatness of attire, pleasing manners, correctness of expression, gentlemanly or lady-like bearing, can best be induced in the pupils by the example of the teacher.

"All the provisions hitherto described would be of none effect, if we took no pains to procure for the public school thus constituted, an able master, and worthy of the high vocation of instructing the people. It cannot be too often repeated, that *it is the master that makes the school.*"
—Guizot.

"Survey those thickly-seated benches. Before us are clustered the children of to-day, the men of to-morrow, the immortals of eternity! What costly works of art, what splendid galleries of sculpture or of painting, won by a nation's arms, or purchased by a nation's wealth, are comparable, in value, to the *treasures we have in these children?*"
—Horace Mann.

"Society is waiting, calling—earnestly, anxiously—for men and women of broader culture and nobler nature—men and women of quick intelligence, of enlightened understanding, of large heart and generous impulse, to take these little ones by the hand and lead them into the pleasant ways of wisdom, virtue, usefulness, and happiness."
—Howland.

Scholarship—You will notice in Principle II that Payne says: "The teacher must be a scholar." The scholarship should be *broad* without being *shallow*; it must be sufficient to meet all the needs of the school—but it should not be obtained by cramming for the occasion. The teacher should be a generous reader of good books, but not an omniverous reader of everything which falls in his way. He should be a student, and it is often well for the school if he is pursuing some chosen line of reading or investigation for his own interest. His scholarship should lead to a development of his powers of thought. There are too many teachers whose scholarship is superficial, who skim over the surface, but who never dive in search of *treasures* which are *hidden* in the *deep places*. The best teacher is one whose soul is imbued with a love of knowledge, and who can bring to his classes the ripe fruit of a mind thoroughly trained to reason, to judge, to conclude; in a word trained to think.

McMurry says: "It is clear, then, that we proceed from the known to the unknown in learning, or that we get out of a thing what we put into it." The height of scholarship, however, is often to get out of a thing what some one else has put into it. We get out of a book not what we put into it but what the *author* has put into it. The scholarship of the teacher must stimulate the pupil to do this.

"First of all, the teacher must be a *scholar*, and no part of his professional education must be conducted at the expense of scholarship. Under scholarship I would include some sensible degree of literary culture, one indication of which is a *pronounced love of good books*."
—Payne.

"We are put here to grow, and we *ought* to grow, and to use all means of growth according to the laws of our being." —Clarke.

"It is better positively to know that one thing is true than to speculate on the possible truth of a dozen others." — B. A. Hinsdale.

Growth—The teacher should never come to the *end* of his *resources*. To avoid this he should be a reader of educational literature, and a student of whatever branches he undertakes to teach. It is a credit to a teacher when it can be said of him that he studies the lessons which he expects to hear the pupils recite.

Bear this in mind, however. The *pupil* studies with the view of *reciting the lesson*:—the *teacher* should study with the view of *conducting the recitation* so as to aid the pupil in getting the most possible out of the lesson.

This point is worthy of careful consideration by the teacher. It is one thing to run over the lesson just before the class is called, with a view of knowing what is in it; it is a very different thing to prepare it with the view of ascertaining what points will need explanation and elucidation; in what respects supplemental information may be given, errors corrected and principles restated.

"The teacher should thoroughly understand what he attempts to teach. It is destructive of all life in the exercise, if the teacher is constantly chained down to the text book." —Page.

"Going to his class so full of the subject, that were the text-book annihilated, he could make another and better one—he will have no difficulty to secure attention." —Page.

"A person cannot teach a rule of arithmetic intelligently, without having himself mastered many advanced rules. Your own experience, if you watch it, will force this truth upon you." —Fitch.

"Before undertaking a matter so simple as hearing a class read, we should glance over the passage and determine on what words it will be well to dwell by way of explanation and what form of illustration should be brought to bear upon it." —Fitch.

"A true teacher never thinks his education complete, but is always seeking to add to his own knowledge. The moment any man ceases to be a systematic student, he ceases to be an effective teacher."—Fitch.

Humane—In the third principle Morgan states that "a man without a heart has no business to be a school-master." One of the strongest elements which is found in the life of every true teacher is sympathy. It is no part of the teacher's vocation to repress the self-activity of the child, but to guide it so that it may become a factor in his growth.

The heart of the little child responds to loving words and kind deeds as the strings of the instrument to the touches of the skillful player.

Patience combined with firmness; with no show of severity, yet with no slackness in maintaining good order; with a deep abiding interest in whatever promotes the welfare of each child at home as well as at school,—these must be included in the teacher who deserves success. It is an easy thing to keep school; it is a great and noble thing to be a true teacher.

The following extracts from that prince of English school-masters. Edward Thring, will bear careful study:

"A teacher is a combination of heart, head, artistic training, and favoring circumstances. Like all other high arts, life must have free play or there can be no teaching."

"Noble character is trained by noble example of life, and by honest surroundings, whether in word or deed. The highest beliefs and the most true work train noble character The teacher must have high beliefs, and be allowed to teach in their spirit."

"If all the bones are put into lessons, and all the loveliness, the life, the feelings, the pleasure flung away, no one need wonder that lessons have ill luck."

"Light up the magic lantern of common things."

"Yes, gentlemen; and we also, in doing this, have discovered the first law of teaching, the first article of the teacher's creed: *Work from the inside outwards.*"

"Any fool with knowledge can pour it into a clever boy; but it needs the skilled workman to be able to teach."

METHODS.

LANGUAGE.

The end and aim of all language teaching should be to secure accurate and fluent use of pure English. Language is the expression of thought. "When words cease to signify ideas, and sentences to express thought, they are no part of language or language lessons." Pupils must get thought before they can give it. Language teaching, therefore, must deal with the processes of thought-getting and thought-giving.

I. PRIMARY GRADES.

While language and reading are inseparably connected in the work of these grades, each needs specific treatment. In order to secure the best results you should have language lessons which are distinct from reading lessons.

1. Secure accurate and fluent oral expression. This is the first duty of the teacher of language, and all the work which the pupils do should be planned with this end in view.

(a) Hold conversation lessons with the pupils, and in this way become acquainted with their vocabulary. Notice any wrong habits of speech which they have acquired, and skillfully substitute correct forms.

(b) Make use of your observation lessons for the purpose of giving the pupils ideas. Lead them to talk freely about what they see and do both in and out of school.

(c) Study the errors in common use by your pupils; classify them. You will find that they practically reduce to errors in the use of the verb, the pronoun, and the

preposition; these are the errors which you will need to give special attention. See *Some Common Errors in the Use of Words*, *Instruction Book IX*, page 77.

(d) Lead the pupils to correct their errors in speech. This is one of the most delicate tasks which you will have to perform in all your teaching. The utmost freedom is necessary to fluent expression. If corrections are made in such a manner as to cause the pupil to feel the least embarrassment, one of the objects of the work is lost. Corrections should usually be made incidentally by giving the correct form and asking the pupil to repeat it. When the form has been given the pupil, his attention should be called to it continually, until its use becomes a habit.

2. Written language. The written work in language begins with the copying of words and sentences from the reading lessons. However, the greatest stress is placed on the relation of this work to the reading during the first weeks. After this the language phase of the work should receive attention.

(a) Train pupils from the first to use correct forms. Capitals and the period should be used in the first sentence that the child writes. Lead the pupils to consider these as a part of the sentence.

(b) Remember that these forms are learned from imitation, and place before your pupils only such forms as they can copy correctly. It is much easier to prevent the formation of bad habits than it is to correct them.

(c) Teach the uses of the different marks of punctuation, such as the interrogation point and comma, when they are needed.

(d) Use the material from the reading lessons, nature study, and stories, for the written work in language.

(e) See that the pupils are "full of the subject" before requiring original productions from them.

3. Make all lessons language lessons in so far as correct expression is concerned. Correct habits of speech will never be secured from slipshod methods. Accuracy must be insisted upon in all recitations. The use of pure English becomes habitual only through practice.

4. Become a living example of what you would teach in language. "As the teacher teaches in this, as in everything, by example as well as by precept, he should be very careful to acquire an unexceptionable use of our language, and never deviate from it in the hearing of his pupils or elsewhere." David P. Page.

II. INTERMEDIATE AND GRAMMAR GRADES.

The work done in language in the intermediate and grammar grades should enable the pupils to express themselves with ease and accuracy in either speaking or writing, and make them acquainted with the application of the fundamental principles of English grammar. The work is a continuance of that done in the primary grade, only on a more extended plan.

1. Written work. This should be along two lines: drill work, and original composition.

(a) The drill work should be for the purpose of fixing right forms in the pupil's mind. Exercises in spelling, copying portions of reading lessons and stanzas of poetry, furnish good examples of what this work should include.

(1) Classify your exercises, as drills on the use of capitals; drills on the use of the comma; drills on the use of quotation marks, and so on. In this way you will be sure of doing definite work.

(2) Insist upon accuracy. The work should not be accepted unless it is an exact reproduction, or production of what is required.

(b) Original composition. This should be carried along with the drill work. Vary the exercises so as to maintain the interest

(1) Reproduction of stories told or read. This work should be very simple at first, and increase in length and difficulty until in the highest grades it includes reproduction of some of the selections from our best authors.

(2) Letter writing. The pupils should begin this exercise as early as the third grade, and continue it until they can write a good letter either of business or friendship.

(3) Discussion of topics. Material for this work can be obtained from the history, geography, literature and other lessons. Abstract themes should be avoided, for children can not discuss them. Study the great industries of the country and kindred topics, and you will find an abundance of material for successful work. Read *Teaching Written Language*, *Instruction Book IX*, page 141.

2. Oral language. The objects of this line of work should be fluency in expression, correctness in speech, and continuity of thought.

(a) Lead your pupils to recite a portion of their lessons by topic. Have each pupil give as complete a discussion as possible of the topic assigned. Geography, history and literature are especially suited to this form of recitation.

(b) Have the pupils commit to memory selections from standard authors. Read *How and What to Remember*, *Instruction Book IX*, page 107.

(c) Have pupils give oral reviews of books and articles which they have read.

(d) Have occasional discussion by pupils of the older classes.

(e) Introduce the terms and principles of grammar incidentally, beginning in the fourth grade. Subject and predicate can easily be introduced in this grade. See that each term is understood when it is introduced, and call attention to it from that time until it becomes perfectly familiar. In connection with subject and predicate, teach the parts of speech which perform these functions in the sentence. Teach the names given in the grammar, as noun, pronoun and verb. Children learn these terms just as readily, and understand them just as well, as they do name-word and action-word. The other parts of speech should be taught in the same way. Begin with the descriptive adjective, then pass to the adverb. When the pupils have a clear idea of these pass to the words which denote relation — preposition, conjunction and relative.

Remember that children do not object to talking or writing about subjects that they understand and have an interest in. See that their minds are filled with information which is useful, and with truth that is elevating, and they will become proficient in the use of language.

STUDIES.

I.

1. What are the essential terms entering into a teacher's contract? Which of these terms are teachers most liable to violate?

2. Why should the teacher refrain from indulging in practices of doubtful propriety?

3. What influence does the personal appearance of the teacher, such as neatness, manners and bearing, have upon the pupils?

II.

1. State at least three reasons why the teacher needs to know much more of a subject than he has to teach.

2. Make a list of the books that you have read during the past year. From which did you receive most help?

3. Read some good article in a magazine or educational journal, then write an abstract of it.

III.

1. The teacher should be a student. Give several reasons why you can teach better, when pursuing some subject for your own advancement.

2. Consider what advantages you derive from being a systematic reader of some good magazine and newspaper. If you have not formed this habit of reading, why not?

IV.

1. How should the teacher's preparation of the lesson differ from the pupil's?

2. Why does the teacher need to know the plan and purpose of the text-book before beginning to teach it.

ELEMENTARY AGRICULTURE

ELEMENTARY AGRICULTURE.

THE PLANT—THE SEED.

Every seed, however small, has two parts: the embryo or germ, and the food upon which the embryo feeds until its rootlets have penetrated the soil, and its leaves unfolded in the air. In large seeds, like the bean, acorn and many nuts, the embryo and food parts can be easily distinguished by soaking the seed for a short time, then splitting it open. Beans, peas, and nuts are found to contain two parts, and open along the line of division. These parts are joined together at one end of the seed, or, as in the bean, at one side. In the bean the tiny leaves of the embryo appear just above the point where the sides are joined. In small seeds, such as wheat, clover, and many others, the parts can not be distinguished except with the aid of a good microscope.

The internal structure of seeds differs, as well as their external appearance, but all contain the parts named. If you watch the germination of beans, peas, and corn, you will discover that each grows on a somewhat different plan. See Studies. This is due to the form of the embryo and the methods of storing the food in the seed. This variety in plan will appear in the description of the next process.

I. GERMINATION.

The germination or sprouting of seeds requires certain conditions; these are:

1. *Moisture.* Dry seeds will not germinate, and the preservation of seeds depends upon keeping them dry from the time of harvest until they are planted, or used

in some other way. By placing seeds in damp soil, on cotton floated over water, or between layers of damp cloth or blotting paper, they will sprout in a few days, provided other conditions are favorable.

2. *Heat.* Seeds will not grow below a certain temperature. If moisture is supplied, and the seeds are kept in a cold place, germination will not take place. But few seeds will sprout in a temperature below 50°, and a temperature of 70° or above is desirable for the best results with most plants.

FIGURE 1.

3. *Air.* The third condition essential to germination is air. Seeds immersed in water, or planted in soil containing an abundance of free water will not grow. Oxygen is necessary and this can be obtained in a free state only from the air. Soil air is as necessary to germination as soil water.

Not only are these conditions essential to germination, but they must be present within certain limitations. Too much or too little heat is fatal to the process, likewise too much or too little moisture. As the amount of air in the soil is regulated by the amount of moisture and the texture, this condition does not of itself need special attention.

By carefully watching growing seeds we can easily discover the plan of development. A little point called the sprout first appears; this bends downward into the soi.

and forms the root. Another point soon follows the first, and works its way upward into the air; this forms the stem. From the stem the leaves soon unfold and then the tiny plant has its organs of growth formed and in action. Some seeds like the bean and the squash first present two thick leaves, shaped very much like the seed, and between these the regular leaves of the plant appear (Fig. 1). The thick leaves soon wither and fall. The food for the embryo was stored in these leaves, and they withered when their supply of food had been exhausted. If you search for the seed, you can not find it. If you examine a growing pea (Fig. 2), you find that the first leaves which appear are like all that follow; the pea will also be found in the ground attached to the growing plant. The same is true of corn (Fig. 3), except that the corn has one seed leaf, while the pea has two. These three plans of germination include most of the seeds of the crops ordinarily planted by the farmer.

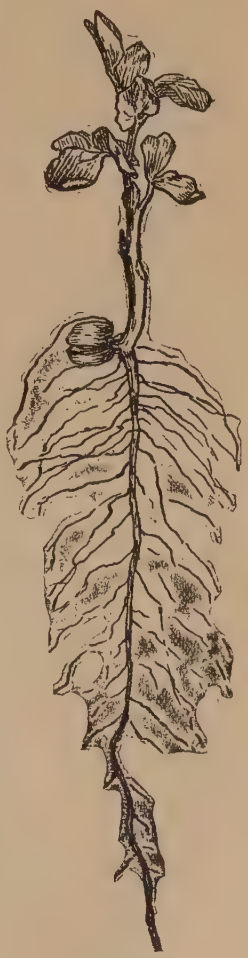

FIGURE 2.

II. CONSTITUENTS OF THE PLANT.

We have already spoken of the substances especially related to agriculture and mentioned some of them as constituting the greater portion of all living organisms.

See Book I. The great variety of substances obtained from plants would indicate that a large number of ingredients was to be found in them, but they are made up almost entirely of the organic elements, oxygen, carbon, hydrogen and nitrogen in varying proportions, with the addition of small quantities of mineral matter such as sulphur, potash and silica.

FIGURE 3.

The substances most important to the life and growth of the plant are water, wood fiber, starch, sugar, and various compounds containing nitrogen and usually termed albuminoids. Water is composed of two parts hydrogen and one part oxygen, while wood, sugar and starch contain carbon, oxygen, and hydrogen. Plant growth consists in obtaining these substances from external sources and making them into plant tissue. We can understand how this is done by observing the work of each of the parts of the plant,—root, stem, and leaves.

In order to understand how these parts of the plant work, it is necessary to become somewhat familiar with the structure of the various tissues. If we examine any part of a plant under a powerful magnifying glass we find it to be composed of minute cells. These cells take different forms in different plants, and in different tissues of the same plant. It is through the cells that all life processes are carried on, and a study of the different parts of the plant will reveal the functions of the cells in each part.

III. THE ROOT.

The root is the descending axis of the plant. The root holds the plant in position and furnishes it with the moisture and the nourishment obtained from the soil.

1. *Form.* Roots assume a great variety of forms. Some plants, like the beet and turnip, have a thick, fleshy root extending directly downward. Such a root is usually called a taproot. The roots of trees extend in all directions, but every tree has a number of large roots to which the smaller ones are attached. Grasses, grains and many small plants have a large number of small roots, all about the same size; roots taking this form are usually termed fibrous roots.

2. *Structure.* Roots have usually a tough, fibrous structure, the fleshy taproots like the turnip and beet being an exception to the general rule. Roots are usually more flexible than the stem and their tissue is composed of long, tubular cells. On account of their small diameter, these cells are sometimes termed thread-like. They constitute the capillary tubes through which the water and nourishment from the soil are drawn up into the plant.

Roots grow at the end. On the point of each root or rootlet is a tiny cap so hard that the growing root can push it down into the soil. When it meets an obstruction like a stone, the root bends around it. Each root and rootlet is covered with tiny root-hairs through which most of the water and plant-food is absorbed.

3. *Work.* Each root-hair is a minute capillary tube with a mouth-piece just above the cap on its end. The large number of these hairs gives the plant an extensive root-surface. In many plants this equals or exceeds the surface of the stem and leaves. The soil water holds the

plant-food in solution as already stated, Books I and II, and in this form it is absorbed by the roots. The amount of absorption is greater than one would think. A common plant of oats or wheat absorbs through its roots many times its own weight of water during its lifetime, and grasses have been known to absorb their own weight of water every 24 hours during dry weather The rootlets should be guarded with the greatest of care during the process of transplanting.

IV. THE STEM.

The stem is the acending axis of the plant, and with few exceptions appears above ground. The stem bears the leaves, flowers and fruit. It has a great variety of forms and positions, and is in many ways more complicated than the root.

1. *Form.* Stems assume a great variety of forms, from the giant trunk of the oak to the tiny stalk of the smallest herb. While the stems of most plants grow approximately erect and have the power to maintain an upright position without support, there are some that twine about or cling to whatever objects are near at hand in order to maintain an upright position, and others that naturally trail upon the ground.

Some stems, like those of grains are round; others like the cornstalk are concave on one side; those of the mint family are square; a few are triangular, and some are oval.

2. *Structure.* The structure of stems is much more complex than that of roots. While the root is composed of only one kind of tissue, most stems contain several kinds. The structure of a stem can be studied to the best advantage by examining the branch or trunk of a tree.

Split the stem through the middle and observe the different tissues from the center outward. You will find the pith or heart wood, the live or sap-wood, the growing layer between the wood and the bark, the green bark and the rough bark on the outside. If the stem is cut across and the end examined with a magnifying glass it will be seen that these different tissues are arranged in concentric layers.

The fiber in the stem as in the root extends lengthwise, and the tube-like cells of the various tissues communicate with each other by means of openings in their walls so as to form continuous tubes connecting with the roots at one end, and the leaves at the other. In trees these tubes become filled in the heart wood and in this way add strength and firmness to the trunk.

The stems of grasses are usually hollow and at frequent intervals contain joints called nodes. An examination of the stems shows that they also contain several tissues. These can frequently be separated by pulling them off. Some stems, like those of the corn and flag, have their woody fiber scattered through the pith in bundles. See Studies.

3. *Work.* The living portions of the tree are next to the bark. Through these the tubes extend for the conveyance of the sap. As the water with its plant food in solution is taken up by the roots, the capillary tubes in the stem convey it to the branches and leaves.

This water holds in solution not only the plant food taken from the soil, but other substances secreted by the tissues of the plant. On its way to the leaf it is known as the crude sap. It usually has the flavor and odor of the plant, and in some cases may be extracted for practical purposes, as in the manufacture of maple sugar.

There are two movements of the sap in the stem; that of the crude sap upward from the roots to the leaves, and that of the perfected or elaborated sap downward from the leaves to the roots. In trees this downward movement takes place between the bark and the wood, and during its passage the sap deposits the annual layer of growth. In small plants, like the grasses, the circulation is not as distinctly marked as in trees, but it is on the same general plan. The functions of the stem, then, in the life and growth of the plant are to furnish a means for the circulation of the sap, to support the leaves in which the sap is digested, and to support the flower and fruit by which the plant is reproduced.

V. THE LEAF.

The leaf is an arrangement for presenting an expanded surface of the plant to the sun and air. An abundant foliage not only adds beauty to vegetation, but is necessary to the health and growth of nearly all plants.

1. *Form and structure.* The forms of leaves are so dependent upon their structure that we can not consider these topics separately. Leaves are made of two parts, framework and pulp or leaf tissue. The framework contains considerable woody fiber, and is quite strong. We usually refer to it as the ribs or veins. Filling all the spaces between the veins and veinlets, is a peculiar tissue containing in most leaves a green substance called by botanists, chlorophyll. A thin membrane, or epidermis, covers both surfaces of the leaf. On the under side of the leaf this membrane is perforated by a large number of openings called stoma or stomata. It is through these pores that the air comes in contact with the cells in the leaf tissue.

2. *Work.* The function of the leaf is somewhat complicated and difficult to understand. It is through the leaf that the plant obtains that portion of its food which it derives from the air, and the leaves perform a function in the life and growth of the plant quite similar to that performed by the lungs. All vegetable tissue contains a large proportion of carbon. When plants are partially burned, this appears as charcoal. The carbon is taken from the air by the leaf. We have already stated that a small percentage of carbon dioxide was found in the atmosphere. See Book I. Carbon dioxide contains two atoms of oxygen to one of carbon. As the air comes in contact with the chlorophyll, its carbon dioxide is absorbed and under the direct action of sunlight it is decomposed. The carbon is retained and becomes plant food, while the oxygen is returned to the air. This combined action of the leaf and sunlight is called photosynthesis, a name which signifies putting together under the action of light. This is considered as the most important function of the leaf.

Another important function of leaves is connected with the circulation of sap, and is known as transpiration. In order to secure the necessary amount of food from the soil, plants have to absorb much more water than they need. This has been briefly referred to under the work of roots, but a more definite estimate will make this function of the leaf clearer. In order that water may be absorbed there must be some means by which it can pass from the plant. This is found in the leaves. By continual evaporation through the pores a constant flow is kept up from the soil to the air. The amount of water thus carried by plants is almost beyond belief.

Some of this water is of course lost by evaporation through the soil but the greater part of it passes into the air by transpiration. See Studies.

The third function of the leaf is that of respiration. By respiration oxygen is taken in and carbon dioxide is given off. While photosynthesis takes place only during the day, respiration occurs at all hours of the day or night.

The result of all these processes carried on in the leaf may be summed up in one word, nutrition. All plant food must be made into living substance, protoplasm, before it can become available for building plant tissue. The various elements of plant food enter the leaf in a crude state; there they are transformed into sugar, starch and albuminoids, and return in the elaborated sap prepared to contribute to the growth of the plant. See Studies.

The perfection of the plant is the great aim of agriculture, for upon it the farmer must depend for most of his income. Plants contribute to our needs by supplying us with material for food, for clothing, for building purposes, for fodder for our domestic animals, and for many of the luxuries of life. Besides this they shade and beautify the earth and make it a delightful dwelling place.

STUDIES.

I.

1. Make a collection of seeds. Use boxes or small bottles with large mouths for storing. Label each package. Become so well acquainted with the appearance of the plant from which each kind is taken that you can tell from the appearance of the seed what plant it will produce. This knowledge is valuable in selecting seeds for planting.

2. Soak a few beans, peas and squash seeds for a day, then remove the outer coat; open the inside along the line of separation and look for the germ.

II.

1. Place a number of peas, beans, squash seeds, kernels of corn, and grains of wheat or oats, on cotton. Float the cotton on water in fruit jars and keep in the sun. Study the development of germination from day to day.

2. Plant some of these seeds in a box of earth. After they have appeared above ground, dig up a number very carefully and compare the roots with the roots of those which germinated over the water. How do you account for the difference?

III.

The study of the structure of plants is interesting and leads one to gain valuable information. Try to perform the following experiments and make notes of what you learn from each.

1. Procure a small vial of tincture of iodine from a drug store; put about three drops into a tablespoonful of water, then apply this solution to the surface of a potato,

a turnip, and an apple. Iodine turns starch blue. What do you learn from the experiment?

2. Cut the branch of a tree across with a sharp knife. Notice the appearance of the end. By using a branch about an inch in diameter you can see the parts without a magnifying glass.

Treat a section of corn stalk in the same way and compare the ends.

Split both stems through the middle and compare the surfaces. What do you learn from these studies?

IV.

1. Make a careful study of the leaves from several different plants and notice the structure. What are the functions of the veins?

2. The transpiration of plants can be shown by the following experiment: Invert a perfectly dry fruit can over a small growing plant. In a short time the inside of the jar will be covered with moisture, which will trickle down in drops. Or take a strong, vigorous leaf, run the leaf-stalk through a hole in a piece of cardboard, and set the cardboard over a tumbler nearly filled with water. Have the cardboard large enough to completely cover the tumbler. Invert a dry tumbler over the leaf and in a short time moisture will collect on the inside of it.

4. To show the portion of the stem through which the sap ascends, take a small branch of a tree or shrub, a stem of growing corn, one of celery, and one from some grain. Place the ends in water that has been colored red. After a few hours cut the stems across a few inches above the water, and notice the colored portions. It is through these that the sap circulates.

HIGHER ALGEBRA

A power is a product arising from multiplying a quantity by itself. (1)

The degree of the power is indicated by the number of factors taken.

Involution is the process of raising an expression to any required power. (2)

If an exponent is a positive integer, it indicates a power of the quantity; if it is a positive fraction, the numerator indicates the power and the denominator the root of the quantity; and if a negative integer or a fraction, it indicates the reciprocal of what it would signify if positive. (3)

In every power there are three things to be considered: The quantity which enters as a factor, and which is called the first power; the expression which is called the exponent of the power, and shows how many times the quan-

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(1) It will be seen that a power is a species of composite number in which the component factors are equal.

(2) A power is indicated briefly by means of the exponential sign. Thus, $a = a^1$ denotes first power of a;

$a \times a = a^2$ " square, or second power of a;

$a \times a \times a \times a = a^4$ " fourth power of a;

$a \times a \times a \ldots = a^m$ " mth power of a.

(2) "The operation of involution may always be expressed by the use of the proper exponent, the expression involved being inclosed by parentheses." —Newcomb's *College Algebra.*

(3) It is obviously incorrect to read $4^{\frac{2}{5}}$, *the two-fifths power of 4.* There is no such thing as a two-fifths power, as will be seen by considering the definition of a power. Read $4^{\frac{2}{5}}$, *4 exponent two-fifths;* read $a^{\frac{m}{n}}$, *a exponent m over n,* also read $a^{-\frac{m}{n}}$, *a exponent minus the fraction* $\frac{m}{n}$. In this way any exponent, however complicated, is read without difficulty.

tity enters as a factor; and the power itself, which is the final product or result of the multiplication. (4)

From the law of signs in multiplication, it is evident that all the *even* powers of a quantity are positive, and that *all odd* powers have the same sign as the quantity itself. (5)

To develop a fraction both terms must be raised to the given power. (6)

The lower powers of some binomials are easily written without the actual multiplication. In another paper, a full treatment of what is called the binomial theorem will be given, by the use of which any power of a binomial in the usual form may be written at once.

The operation of finding any required root of an expression is called evolution. A root of an imperfect power can not be found exactly.

The root of any quantity is a factor which being multiplied by itself a certain number of times produces the given quantity.

The fourth root of $81a^{12}$ is either $3a^3$ or $-3a^3$, and the fifth root of $-3125b^{20}$ is $-5b^4$. The root of a simple

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(4) If it is required to raise $2a^3b^2$ to the fourth power, we have $(2a^3b^2)^4 = 2a^3b^2 \times 2a^3b^2 \times 2a^3b^2 \times 2a^3b^2$. By the rules for multiplication this product is $2^{4}a^{3+3+3+3}b^{2+2+2+2}$ or $2^4a^{12}b^8$. As the exponents are equal, we may *multiply* each exponent by the number denoting the power, which gives us the result at once.

(4) What is the cube of $6a^5y^2$? What is the fifth power of $2a^2m^n$? What is the square of a^mb^n?

(5) What are the square and also the cube of $-2a^2b^2$? What is the sixth power of $-a^nb^{2n}c^{-1}$? What is the fifth power of $-x^{n-1}y^{m+1}$?

(6) What is the square of $\frac{2}{3}$? What is the cube of $-\frac{a^8}{b^5}$? What is the fourth power of $\frac{-a}{c^{-2}}$?

expression is readily found by taking the required root of the numerical coefficient, and by dividing the exponent of each letter by the index of the required root. (7)

By the rule of signs it is evident that any even root of a positive quantity may be either positive or negative (8); that every odd root of a quantity has the same sign as the quantity (9); and that there can be no even root of a negative quantity. (10)

When the coefficient is not a perfect power of the degree indicated, or when the exponent of any letter is not exactly divisible by the index of the root, the monomial is an imperfect power of the degree indicated. Thus, $16a^2b^4$ is an imperfect cube, and $21xy^3$ is an imperfect fourth power. Their roots are indicated thus: $\sqrt[3]{16a^2b^4}$, $\sqrt{21xy^3}$.

To obtain any root of a fraction, find the root of the numerator and of the denominator, and give the proper sign to the result. Thus, the square root of $\frac{81x^{10}}{289y^4z^6} = \pm\frac{9x^5}{17y^2z^3}$. (11)

(7) Show that the square root of $a^8b^8c^{12}$ is $\pm a^4bc^6$. Also that the cube root of $-343a^{12}b^{18}$ is $-7a^4b^6$.

(8) Thus, $a\times a=a^2$, $(-a)(-a)=a^2$; therefore there are *two* roots of a^2; namely, $+a$ and $-a$. Since every positive quantity has two square roots equal in magnitude but opposite in sign, it is customary to prefix the double sign $\pm$, read *plus or minus*, to a quantity when we wish to indicate that it is either $+$ or $-$.

(9) $(-a)(-a)(-a)=-a^3$; therefore the cube root of $-a^3$ is $-a$. The cube root of a^3 is $+a$.

(10) There can be no square root of $-a^2$; for if any quantity be multiplied by itself, the result is a positive quantity. There can be no even root of a negative quantity, because no quantity raised to an even power can produce a negative result. The indicated even root of a negative quantity is called an imaginary root.

The fractional exponent has the same meaning as the radical sign, and may be used in place of it. Thus, the square root of m^4 may be indicated either $\sqrt{m^4}$ or $m^{\frac{4}{2}}$. (12)

Since the square of $a+b$ is $a^2+2ab+b^2$, the square root of $a^2+2ab+b^2$ is $a+b$.

It is required to find a method for extracting the square root, $a+b$, when $a^2+2ab+b^2$ is given. (13)

Extract the square root of the polynomial

$$49a^2b^2-24ab^3+25a^4-30a^3b+16b^4. \quad (14)$$

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(11) What is the fourth root of $\frac{16a^4y^4}{625z^8}$? The third root of $\frac{343x^{-3}y^{-}}{a^{-9}b^{-18}c^6}$? The fifth root of $-\frac{b^5c^{5n}x^{5m}}{32y^{5p}z^{5q}}$?

(12) Express by both methods, the fourth root of a^3; the square root of $(a+b)^3$; the fifth root of a^n; the nth root of $(a+b)^m$; and the nth root of $6a^nb^{2n}$.

(13) "The first term, a, of the root is obviously the square root of the first term, a^2, of the expression.

$a^2+2ab+b^2 \mid a+b$ (2a+b)

a^2

$2ab+b^2$

$2ab+b^2$

If the a^2 is subtracted from the given expression, the remainder is $2ab+b^2$. Therefore, the second term, b, of the root is obtained when the first term of this remainder is divided by $2a$, that is, by *double the part of the root already found.* Also, since

$$2ab+b^2=(2a+b)b,$$

the divisor *is completed by adding to the trial divisor the new term of the root.*"

—Wentworth's *New School Algebra.*

(13) "All even roots admit of a double sign. Thus the square root of $a^2+2ab+b^2$ is either $a+b$ or $-a-b$, as may be verified. In the process of extracting the square root of $a^2+2ab+b^2$, we begin by extracting the square root of a^2, and this may be either a or $-a$. If we take the latter and continue the operation by the rule as before, we shall obtain $-a-b$. A similar remark holds in every other case."

—Bowser's *Academic Algebra.*

(14) First arrange it with reference to the powers of the letter a.

An approximate value of an imperfect square can be found to any required number of terms. (15)

Solve a large number of problems in square root selected from some good text-book.

Since the cube of $a+b$ is $a^3+3a^2b+3ab^2+b^3$, the cube root of $a^3+3a^2b+3ab^2+b^3$ is $a+b$. We may

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$$
\begin{array}{l|l}
25a^4-30a^3b+49a^2b^2-24ab^3+16b^4 & 5a^2-3ab+4b^3 \\
25a^4-30a^3b+\ 9a^2b^2 & \overline{10a^2} \\
\hline
40a^2b^2-24ab^3+16b^4 & \text{1st rem.} \\
40a^2b^2-24ab^3+16b^4 & \\
\hline
0 & \text{2d rem.}
\end{array}
$$

After having arranged the polynomial with reference to a, extract the square root of $25a^4$: this gives $5a^2$, which is placed at the right of the polynomial. Then divide the second term, $-30a^3b$, by the double of $5a^2$, or $10a^2$: the quotient is $-3ab$, which is placed at the right of $5a^2$. Hence [the first two terms of] the root are $5a^2-3ab$. Squaring this binomial, it becomes $25a^4-30a^3b+9a^2b^2$ which, subtracted from the given polynomial, leaves a remainder of which the first term is $40a^2b^2$. Dividing this first term by $10a^2$ (the double of $5a^2$), the quotient is $+4b^2$: this is the third term of the root, and is written on the right of the first two terms. By forming the double product of $5a^2-3ab$ by $4b^2$, squaring $4b^2$, and taking the sum, we find the polynomial $40a^2b^2-24ab^3+16b^4$, which, subtracted from the first remainder, gives 0. Therefore $5a^2-3ab+4b^2$ is the required root.

If a final remainder is found equal to 0, the root is exact; if not, the root is only approximate.

(14) The same method will apply to longer expressions, if care is taken to obtain the *trial divisor* at each stage of the process, by *doubling the part of the root already found*, and to obtain the *complete divisor by annexing the new term of the root to the trial divisor.*

(14) It will be noticed that each successive trial divisor may be obtained by taking the preceding complete divisor with its *last term doubled.*

(14) Find the square root of $a^4-4a^3x+6a^2x^2-4ax^3+x^4$.

Also, of $\frac{a^2}{4}-ax+\frac{3a}{2}+x^2-3x+\frac{9}{4}$.

(15) Find to two terms the square root of x^2+px.

deduce a general rule for the extraction of the cube root of a polynomial by observing in what manner $a+b$ may be derived from $a^3+3a^2b+3ab^2+b^3$.

In the usual method, that of division, the complete quotient, which is the root sought, is derived a term at a time, from parts of the dividend, by what may be regarded as really a process of factoring. Why is it helpful to take as a first trial divisor three times the square of the root found? Notice the second term of the quantity. What power of a does it contain? What new letter appears as a factor? When this new factor is taken out, what is left? What relation does this remaining factor bear to the first term of the root? The new letter is the second term of the root; what relation does the remaining part of the second term of the quantity bear to the first term of the root? By a similar course of reasoning, determine why, to form the complete divisor, we add to the trial divisor three times the product of the first term of the root by the second, and also the square of the term last found.

The explanation given is an abbreviated method of indicating the work in extracting the cube root. (16)

$$\begin{array}{l|l} x^2+px & x+\frac{p}{2} \\ \hline x^2 & \\ \hline 2x+\frac{p}{2} & px \\ & px+\frac{p^2}{4} \\ \hline \end{array}$$

(15) Find to three terms the square root of $4-3a$.

(16)

$$\begin{array}{l|l} & 3+4x-2x^2 \\ \hline 27+108x+90x^2-80x^3-60x^4+48x^5-8x^6 & \\ 27 & \\ \hline 27+36x+16x^2 & 108x+90x^2-80x^3 \\ & 108x+144x^2+64x^3 \\ \hline 27+72x+48x^2 & -54x^2-144x^3-60x^4+48x^5-8x^6 \\ -18x^2-24x^3 & \\ +4x^4 & \\ \hline 27+72x+30x^2-24x^3+4x^4 & -54x^2-144x^3-60x^4+48x^5-8x^6 \\ \hline \end{array}$$

Any quantity whose root can be extracted is called a perfect power. When the square root of an expression which is not a perfect square, or the cube root of an expression which is not a perfect cube, is required, the operation cannot be performed.

In addition to the limited number of examples which we give, the student should seek from many sources, problems of several kinds and of different degrees of difficulty, connected with the subject, the careful solution of which will be of the highest value. (17)

The *fourth* root of a polynomial may be found by extracting the square root twice; the *sixth* root by extracting in turn the square and the cube roots, and either operation may be performed first; the *eighth* by extracting the square root three times; the *ninth* by extracting the cube root twice; and so on. (18)

Explanation.— The root is placed above the given expression for convenience. When we have obtained two terms in the root, $3+4x$, we form the second divisor as follows: take 3 times the square of the root already found for the trial divisor, $27+72x+48x^2$; divide $-54x^2$, the first term of the remainder, by 27, the first term of the trial divisor; this gives the third term of the root, $-2x^2$. To complete the divisor we add to the trial divisor 3 times the product of $(3+4x)$ and $-2x^2$, and also the square of $-2x^2$. Now multiply the complete divisor by $-2x^2$ and subtract; there is no remainder and the root is found.

(17) $a^3-a^2b+\frac{ab^2}{3}-\frac{b^3}{27}$. $1-6x^m+12x^{2m}-8x^{3m}$. $\frac{x^3}{y^3}-\frac{3x^2}{y}+3xy-y^3$.

(18) Find the sixth root of $64-192x+240x^2-160x^3+60x^4-12x^5+x^6$. Find the eighth root of $x^8+8x^7+28x^6+56x^5+70x^4+56x^3+28x^2+8x+1$.

(18) Extract the cube root of $204c^4x^2-144c^5x+8x^6-36cx^5-171c^3x^3+64c^6+102c^2x^4$.

Extract the cube root of $27a^6c^3-54a^5c^2+36a^4c-8a^3+27a^4bc^2x-36a^3bcx+12a^2bx+9a^2b^2cx^2-6ab^2x^2+b^3x^3$.

STUDIES.

I.

1. Can you show the square root of $-4x^2$ to be $2x$? The cube root of $9c^6$ to be $-3c^2$? Why?

2. Find by inspection the square roots of $576a^4b^6c^8$; $196x^6y^2z^4$; $\frac{9a^2b^6}{16x^4y^2}$.

3. Find the square roots of:

$$x^4-8x^3+18x^2-8x+1 \text{ and of}$$
$$4x^4-12x^3y+29x^2y^2-30xy^3+25y^4.$$

II.

1. If the root of a quantity is an odd number, will it take the plus or the minus sign? Review the law of signs.

2. Simplify, by inspection:

$$\sqrt[3]{-\frac{8x^3y^6}{27z^9}};\quad \sqrt[4]{\frac{16x^4}{81a^8b^{12}}};\quad \sqrt[5]{-32a^{10}};\quad \sqrt[3]{-\frac{27x^{27}}{64y^{63}}}.$$

III.

1. Extract the square root of $\frac{64x^2}{9y^2}+\frac{32x}{3y}+4$.

2. Arrange in the descending powers of x and extract the square root:

$$15a^2x^4-6ax^5+x^6-20a^3x^3+a^6+15a^4x^2-6a^5x.$$

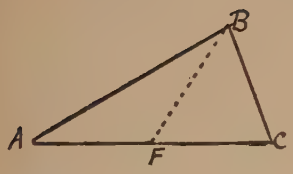
IV.

1. Extract the cube root of $8x^6-36x^5+114x^4-207x^3+285x^2-225x+125$.

2. Find the fourth root of $a^4+8a^3b+24a^2b^2+32ab^3+16b^4$.

3. Find the sixth root of $1+6d+d^6+6d^5+15d^4+20d^3+15d^2$. Arrange in descending powers of d.

PLANE GEOMETRY

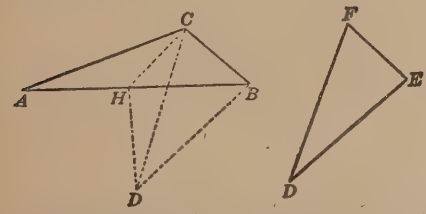


THEOREM XXIV. The greater angle of a triangle lies opposite the greater side, and, conversely, the greater side of a triangle lies opposite the greater angle.

Given $\triangle ABC$, with the side AC greater than the side CB; to prove $\angle ABC$ opposite AC, is greater than $\angle A$, opposite CB. On the line CA, take the distance CF=CB and draw BF. $\angle ABC$ is greater than $\angle CBF$, (Axiom *f*); but $\angle CBF = \angle CFB$, (Theorem XVII). $\therefore \angle ABC$ is greater than $\angle CFB$. Since $\angle CFB = \angle A + \angle ABF$, (Theorem XIV), $\angle CFB$ is greater than $\angle A$, then $\angle ABC$, the angle opposite AC, is greater than $\angle A$, the angle opposite CB. Q. E. D.

Conversely: The greater side of a triangle lies opposite the greater angle.

In $\triangle HMO$, let $\angle H$ be greater than $\angle O$; to prove that MO is greater than HM. MO must either be equal to HM, greater than HM, or less than HM. But MO does not equal HM, for then $\angle H$ would equal $\angle O$, (Theorem XVII); MO is not less than HM, for then $\angle H$ would be less than $\angle O$, (Theorem XXIV). Both these suppositions are contrary to the hypothesis that $\angle H$ is greater than $\angle O$. $\therefore$ MO cannot equal HM, nor be less than HM, and hence must be greater than HM. Q. E. D.

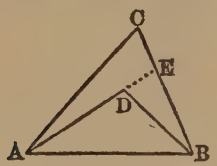


THEOREM XXV. If two triangles have two sides of one respectively equal to two sides of the other, but the included angles unequal, the greater angle is subtended by the greater base.

Given two $\triangle$s, ACB and DFE, having AC=DF, CB=FE, but $\angle ACB$

greater than $\angle F$; to prove that AB is greater than DE.

Place $\triangle DFE$ in the position DCB so that the equal sides, EF and BC, coincide. Draw CH bisecting $\angle ACD$ and draw DH. Since in the two $\triangle s$, AHC and DHC, AC=DC (by hyp.) and CH is common, and (by construction) $\angle ACH = \angle HCD$, the two $\triangle s$ are equal, (Theorem XVI), and AH=DH, (homologous sides). DH+HB is greater than DB, (Axiom *h*). Substituting AH for its equal DH, and we have AH+HB is greater than DB, that is, AB is greater than DB, or its equal DE. Q. E. D.



THEOREM XXVI. If from a point in a triangle, two straight lines are drawn to the extremities of one side, their sum will be less than the sum of the other two sides of the triangle.

Given $\triangle ACB$ and the lines DA and DB drawn from D to the extremities of AB; to prove that AD+DB is less than CA+CB. Prolong AD to meet CB at E, then DB is less than DE+EB (Axiom *h*), and also DA+DE is less than EC+CA (for the same reason); adding these two equations, DA+DE+DB is less than EC+CA+DE+EB; cancel DE from each side and substitute CB for CE+EB and we have DA+DB is less than CB+CA. Q. E. D.

To determine the directions of a line, it has been seen that two points, or a point and a direction, must be known. To determine the position of a point, two lines must be known; or, a direction and a given distance in the given direction will determine the position of the point. If the necessary conditions are not known, the given problem will be indeterminate; thus, a line cannot be found, if the position of only one point is known; nor, can a point be found, if only one of the necessary lines is given.

Something may, however, be known in indeterminate problems, even if the necessary conditions are not all given; thus, if the problem is to determine the *position* of a *line* of given length, and its directions, only, are known, it is obvious that the *required line must lie somewhere in the line of the given directions*. If the problem is to determine the *position of a point*, and the direction is given, but

not the distance in the direction, the *required point must be somewhere in the given line* or direction. In either problem, it remains necessary definitely to locate only one point to fully determine the problem. That which may be known in determining or locating a point, or a line, or other geometrical magnitude, when the necessary conditions are not all given, is not the position of the required point or magnitude, but the *locus*, or place, where one may expect to find it.

The nature of loci becomes clear when we conceive a line as being the path generated by a point moving according to some specified condition. If the point move so as to be always at a given distance from a given fixed point, the line thus traced will be the locus of all points that are at the given distance from the given point.

Thus, a line perpendicular to another at its midpoint is the locus of those points in the plane that are at the same distance from both ends of the bisected line. The locus of a point, then, is the line, or lines, which include all those points, and only those points, that satisfy the given conditions in an indeterminate problem, some of the conditions necessary to determine the point being unknown.

The *locus* of a line or point is inclusive and exclusive; it not only *includes* all lines or points that satisfy the given conditions, but it *excludes* all lines or points that do not satisfy the given conditions.

A locus is always a line either straight or curved; if a curved line, (in elementary geometry) it is either a circumference or an arc of a circumference. If, therefore, the construction of a locus is required, fix any two of its points, connect them by a straight line, produce the line in both directions, apply tests to random points in the line to ascertain if they possess the common property demanded. If so, the problem is solved and it only remains to find the proof. When difficult problems

are to be solved, it is often useful to construct the figure as though the solution were already reached, and then by a careful study of its parts, endeavor to find the way to an original construction.

THEOREM XXVI B. The locus of all points equally distant from two given points is a straight line bisecting at right angles the line joining the given points.

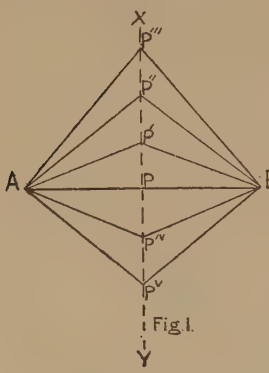


Fig. 1.

Let A and B be two fixed points. To prove that the locus of all points equally distant from A and B is a straight line XY (Fig. 1) perpendicular to AB at its middle point. Let P, P^{i}, P^{ii}, P^{iii}, P^{iv}, P^{v} be any points on XY.

Then AP=BP by construction.

Therefore AP=BP, $AP^{i}=BP^{i}$, $AP^{ii}=BP^{ii}$, etc., according to Theorem VI.

Two oblique lines drawn from the same point in a perpendicular cutting off equal distances from the foot of the perpendicular are equal. Therefore, any point in XY is equally distant from A and B.

Let any point as D be without XY (Fig. 2). Draw AD and DB. One of these lines will cut XY in some point as F. Then DB is less than FB+FD. A straight line is the shortest distance between two points.

But FA=FB—Theorem VI, substituting FA for FB, DB is less than DF+AF, or FB is less than DA. Therefore every point without XY is unequally distant from A and B. Q. E. D.

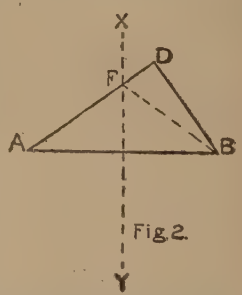
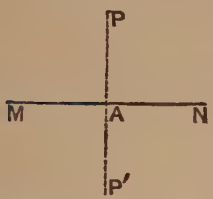


Fig. 2.

The method of *intersection* of *loci* is helpful in solving many determinate problems. For instance, in finding the position of a point that fulfills *two* conditions, while, from each condition, a line that is a *locus* of the point may be found, the point itself, if the problem is possible, will be found at the intersection of the two loci.

Two points are said to be *symmetrical* with respect to a straight line, when the straight line bisects at right angles the straight line joining the two points.



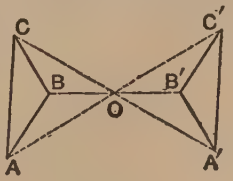
Thus, the two points P and P′ are symmetrical with respect to the line MN, if MN bisects PP′ at right angles. The straight line MN is called the *axis of symmetry*.

If we take the plane containing the point P, and turn it about the axis MN, until the upper part is brought down on the part below MN, the line AP will take the direction AP′, and the point P will coincide with the point P′. Thus, when two points are symmetrical with respect to an axis, if one of the parts of the plane be revolved about the axis to bring it down on the other part, the symmetrical points coincide.

Two points are said to be symmetrical with respect to a third point, when this third point bisects the straight line joining the two points. Thus, P and P′ are symmetrical with respect to A, if the straight line PP′ is bisected at A.

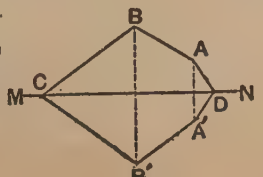
The point A is called the *center of symmetry*.

Two figures are said to be symmetrical with respect to a center, when every point in one figure has its symmetrical point in the other.



Thus, the figures ABC, A′B′C′ are symmetrical with respect to the center O, if every point in the figure ABC has a symmetrical point in A′B′C′.

A figure is symmetrical with respect to an axis, when it can be divided by that axis into two figures symmetrical with respect to the axis.



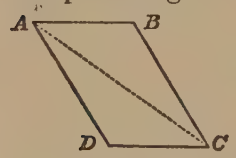
Quadrilaterals are classified according to the parallelism of sides and the equality of angles. The following diagram may be helpful in memorizing the definitions of the different kinds of quadrilaterals:

- Quadrilaterals
  - Trapezium
  - Trapezoid
    - Isosceles—Equal sides
    - Scalene—Unequal sides
  - Paralellogram
    - Rhomboid
      - Rhombus
    - Rectangle
      - Oblique
      - Square

A quadrilateral is a figure bounded by four lines. A parallelogram is a quadrilateral whose opposite sides are parallel. A rectangle is a right-angled parallelogram. A square is an equilateral rectangle. A rhomboid is an oblique-angled parallelogram. A rhombus is an equilateral rhomboid.

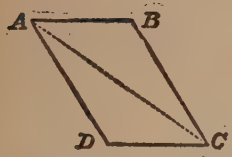
A quadrilateral which has only two sides parallel is called a trapezoid. A quadrilateral which has no two sides parallel is called a trapezium.

The straight lines which join the vertices of the opposite angles of a quadrilateral are called diagonals. The perpendicular distance between the bases of a trapezoid or of a parallelogram is called its altitude.



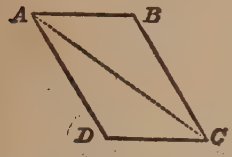
THEOREM XXVII. If the opposite sides of a quadrilateral are equal, the figure is a parallelogram.

Given any quadrilateral ABCD having its opposite sides equal, AB=CD and AD=BC; to prove that the figure ABCD is a parallelogram. Draw the diagonal AC. Then in the two $\triangle$s, ABC and ADC, AC is identical, AB=DC and AD=BC, hence the $\triangle$s are equal, (Theorem XIX). And $\angle ACB = \angle CAD$, (homologous angles.) $\therefore$ BC is $\parallel$ to AD. (Theorem XI). In like manner, using $\angle BAC$ and $\angle ACD$, we may prove AB $\parallel$ to DC. $\therefore$ ABCD, having its opposite sides $\parallel$, is a parallelogram. Q. E. D.



THEOREM XXVIII. The diagonal of a parallelogram divides it into two equal triangles.

Given the parallelogram ABCD and the diagonal AC; to prove that △s ABC and ADC are equal. In the △s, ABC and ADC, AC is identical, ∠ACB = ∠CAD and ∠CAB = ∠ACD, (Theorem X). Hence the △s are equal, (Theorem XV). Q. E. D.

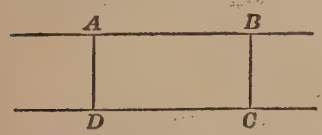


THEOREM XXIX. The opposite sides of a parallelogram are equal.

Let the figure ABCD be a parallelogram; to prove that AB = DC and BC = AD. Draw the diagonal AC. △ABC = △CAD, for AC is common and ∠BAC = ∠ACD, and ∠BCA = ∠CAD, (Theorem X). ∴ AB = DC and BC = AD (homologous sides of equal △s). Q. E. D.

THEOREM XXX. The diagonals of a parallelogram bisect each other.

Given a parallelogram ADCB and its diagonals AC and DB intersecting at E; to prove that AE = EC, and DE = EB. In the △s DEC and AEB, ∠CAB = ∠ACD and ∠ABD = ∠BDC, (Theorem X). Also, DC = AB, (Theorem XXIX). Hence △DEC = △AEB, (Theorem XV). ∴ DE = EB and AE = EC, (corresponding sides of equal △s). Q. E. D.



THEOREM XXXI. Parallels comprehended between parallels are equal.

Given the ∥ lines AB, BC, and AD and BC; to prove that AD = BC. This is proved by applying Theorem XXIX. Q. E. D.

The following exercises will afford a helpful drill, and all should be worked. The student will not find any of them difficult.

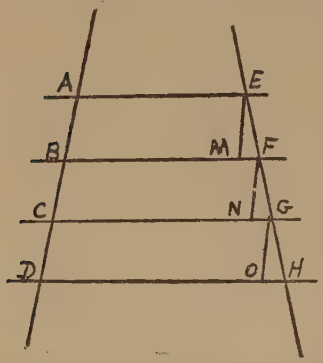
Prove: If two adjacent sides of a rectangle are equal, the figure is a square.

The four angles of a quadrilateral are together equal to four right angles.

A line ∥ to the base of a △ and bisecting one side, bisects the other side also.

The ⊥s from the vertices of a △ to the opposite sides meet in a point.

The diagonals of a square are equal.

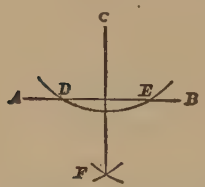


THEOREM XXXII. If any number of parallel lines make equal parts on one transversal, they make equal intercepts on any transversal.

Let the ∥s AE, BF, CG, and DH intercept equal parts AB, BC, and CD on the transversal AD; to prove that they intercept equal parts EF, FG, and GH on the transversal EH.

Suppose EM, FN, and GO drawn ∥ to AD. Then EM=AB, FN=BC, and GO=CD, (Theorem XXXI). ∴ EM=FN=GO, (Axiom *a*.) Also, ∠MEF=∠NFG=∠OGH, (Theorem XII) and for the same reason ∠EFM =∠FGN=∠GHO. ∴ △s EMF, FGN, and GHO are equal, (Theorem XV), and EF=FG=GH, (homologous sides of equal △s). Q. E. D.

Hitherto we have supposed the figures constructed. We now proceed to explain the methods of constructing simple problems, and afterwards, the student should complete the demonstration for himself, with or without the aid of the diagrams.

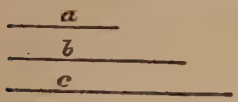


Construction: It is required to let fall a ⊥ upon a given line from a given external point.

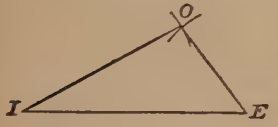
Let AB be the given straight line and C the given external point; to let fall a ⊥ to the line AB from the point C. From C as a center, take a radius sufficiently long so that when revolved about C, it will intersect AB in two points, as D and E. (Perhaps this may be more clearly seen if constructed with a piece of common string. Make a loop of string large enough for the finger, place the finger upon C as a center, and with the free end of the string, swing an arc that

touches AB in two points.) From these two points just found, using each one separately as a center, and using a radius greater than one-half the distance from D to E, describe two arcs, (by *arc*, is meant any part of the circumference of a circle) intersecting at F; draw CF. This will be the ⊥ required, since C and F are equidistant from the two points D and E. (Two points equidistant from the extremities of a line, determine the ⊥ bisector of the line.)

Construction: To bisect a given finite straight line. This construction is left to the student. (Hint: Use construction nearly like the preceding one).



Construction: To draw a triangle when the three sides are given.



Let a, b, and c be the given lines. Draw IE equal to c. With I as a center, and with a line equal to b as a radius, describe an arc, and with E as a radius and a line equal to a, describe another arc so that the two arcs intersect. Join O, the point of intersection of these arcs, with I and E. Then IOE is the required triangle.

Construction: To construct an angle equal to a given angle.

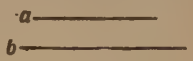
Let A be the given ∠. With the vertex A as a center, and any radius, as AB, describe an arc intersecting the side of the angle in the points B and C. Draw the straight line BC. Draw another line (an indefinite straight line) as DE. With D as a center and a radius equal to AB, describe an indefinite arc EF. With E as a center and a radius equal to BC, describe an arc intersecting the arc EF in F. Draw the straight line DF. The ∠D is equal to ∠A, for AB=DE, AC=DF, and BC=EF.

Construction: Draw a triangle having given two sides and the included angle.

Construction: Draw a triangle having given one side and two angles.

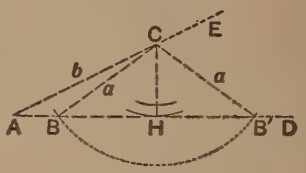
Construction: To construct a triangle, having given two sides and the angle opposite one of them.

Given, the sides a, b, and ∠ A opposite a. Required, to construct the △.



Case I. When a is less than b, and ∠ A *is acute.*

Construction: At point A on the indefinite straight line AD, make the ∠DAE = ∠A. On AE take AC = b. With C as a center, and radius = a, describe an arc cutting AD at B and B′. Join CB and CB′. Then, either ABC or AB′C is the △ required, since each satisfies the given conditions; and the problem has two solutions.



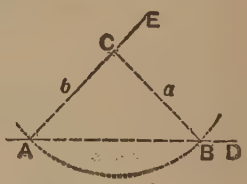
This is called the *ambiguous* case.

When the side a = the ⊥ CH, there is but one solution: the rt. △ ACH, since the arc described with center C and radius a *touches* AD.

When the side a is less than CH, the problem is impossible, since the arc described with center C and radius a does not cut or touch AD. Hence, the arc described with center C and radius a will meet AD in two points; B and B′ equidistant from H; or in one point H; or in no point whatever; according as a is greater than, = , or less than CH. Therefore, there may be two △s, one △, or none at all.

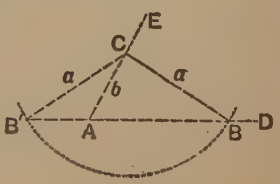
Case II. When a = b, and ∠A is *acute.*

In this case the arc described with center C and radius a, cuts AD at the two points A and B; and hence there is but one solution: the isosceles △ ABC.



Case III. When a is greater than b.

When ∠A is acute, the arc described with center C and radius a, cuts AD in B and B′, the latter point at the *left* of A in DA produced. Then ABC is the △ required, since it satisfies the given conditions, and there is only one solution, for the △ AB′C does not contain the given ∠A.



STUDIES.

I.

1. What is the locus of a point equidistant from the extremities of a given line?

2. What is the locus of a point equidistant from two given parallel lines.

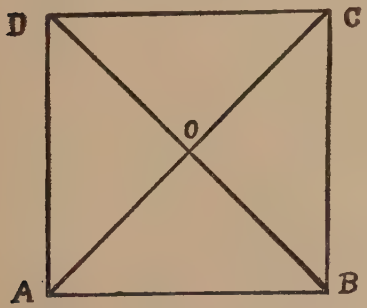
II.

1. Proposition D, allied to Theorems XXIV and XXV. ABC and ABD are two triangles on the same base AB, and on the same side of it, the vertex of each triangle being without the other. If AC equal AD, show that BC can not equal BD.

2. Proposition E, suggested by Theorem XVII. If the angles ABC and ACB at the base of an isosceles triangle, be bisected by the straight lines BD and CD, show that DBC will be an isosceles triangle.

III.

Proposition F, allied to theorems in lesson involving quadrilaterals. The diagonals of a square are perpendicular to each other and bisect the angles of the square.



Given the square ABCD, and let AC meet BD at O. To prove AC $\perp$ to BD and $\angle BAO = \angle DAO$, etc. The $\triangle OAB = \triangle OAD$ (Theorem XIX). $\therefore \angle BAO = \angle DAO$, and $\angle AOB = \angle AOD$. $\therefore \angle AOB = 90°$, because it is a right angle, and AC is $\perp$ to BD. In a similar manner we may prove $\angle ABO = \angle CBO$, and so on. Q. E. D.

IV.

Demonstrate the following theorems, both allied to the work already given in quadrilaterals:

Proposition G. The lines joining the middle points of a rhombus, taken in order, inclose a rectangle.

Proposition H. If the diagonals of a trapezoid are equal, show that the trapezoid is isosceles.

BOTANY

BOTANY.

The stem, or ascending axis, constitutes a prominent part of all ordinary plants. According to structure stems are exogenous, or endogenous. The stem of any tree or shrub is a good example of the first class, and that of corn or grass of the second. (1) Exogenous stems belong to dicotyledonous plants and endogenous to monocotyledonous. See *Instruction Book V*, page 181.

Stems can also be classified according to the kind of leaves they bear. (2) There are many forms and varieties of stems bearing foliage-leaves. In the lowest orders of plants the stem and leaf seem to be one; as the orders

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Note.— In connection with the work of this outline you should collect and study a great variety of stems. Classify them according to structure, according to modes of branching, and according to function.

(1) Compare cross sections of branches from any trees with similar sections of corn stalk, grass, and grains. Draw diagrams illustrating the difference in appearance.

(1) "If an active twig of an ordinary woody plant be cut across, it will be seen that it is made up of four general regions: (1) an outer protecting layer, which may be stripped off as a thin skin, the epidermis; (2) within the epidermis is a zone, generally green, the cortex; (3) an inner zone of wood or vessels, known as the vascular region; (4) a central pith. . . . Sometimes the pith disappears in the older stems or parts of stems and leaves the stem hollow. When the vessels are arranged in this way and the stem lives more than a year, it can increase in diameter by adding new vessels outside of the old. In the case of trees these additions appear in cross-sections like a series of concentric rings, and as there is usually but one growth period during the year, they are often called annual rings, and the age of the tree is often estimated by counting them." — Coulter's *Plant Relations*.

(2) "In classifying stems, therefore, it seems natural to use the kind of leaves they bear. From this standpoint there are three prominent kinds of stems: (1) those bearing foliage leaves; (2) those bearing scaly leaves; (3) those bearing floral leaves. There are some

become more complex in structure, these are easily distinguished. (3)

Some plants, like the dandelion, have very short stems to which the leaves are attached. These are sometimes wrongly called stemless plants. (4) Examine a strawberry plant and notice how new plants are started. What part of the plant are the runners? Do you know of any other plants that send out similar shoots?

Many weak stems lift themselves up by twining around a stronger support. (5) Some attain an erect position by climbing by the means of tendrils. The ivy and the

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peculiar forms of stems which do not bear leaves of any kind, but they need not be included in this general view."

— Coulter's *Plant Relations.*

(3) "Among the lower plants, such as algæ and toadstools, there is no distinct stem and leaf. In such plants the working body is spoken of as the thallus, which does the work done by both stem and leaf in the higher plants. These two kinds of work are separated in the higher plants, and the shoot is differentiated into stem and leaves."

— Coulter's *Plant Relations.*

(4) "Plants live subject to a very fierce competition among themselves and exposed to almost constant attacks from animals. Any plant which can grow in safety under the very feet of grazing animals will be especially likely to make its way in the world, since there are many places where it can flourish while ordinary plants would be destroyed. The bitter, . . . stemless dandelion, which lies too near the earth to be fed upon by grazing animals, and which bears being trodden on with impunity, is a type of a large class of hardy weeds."

– Bergen's *Elements of Botany.*

(5) "Only a few of the upper internodes of the stem of a twiner are concerned in producing the movements of the tip of the stem. This is kept revolving in an elliptical or circular path until it encounters some roughish and not too stout object, about which it then proceeds to coil itself. The direction of the coiling varies in different kinds of climbers, some following the course of the hop from right to left, others, as the morning glory, taking the opposite direction."

— Bergen's *Elements of Botany.*

woodbine are common illustrations of climbing stems. In both cases the object is to reach the light. (6)

Those stems which maintain themselves in an erect position constitute the most important division of foliage-bearing stems, as seen in the largest herbs, shrubs, and trees. The branching of these stems determines the general form of the plant, as can be readily seen by comparing the different varieties of trees and shrubs. (7)

There are two kinds of tree trunks: the excurrent, extending the entire length of the tree, as in the cotton-wood, and the deliquescent or divided trunk, as in the elm. Shrubs have no trunk, and are well illustrated by the alder, currant, rose, etc. Herbs have but little wood fiber in their stems, and die down to the ground in the autumn. Plants which live only one year are called annuals, those which live two years are biennials, and those which live more than two years are perennials. What plants do you know that belong to each class?

Buds and leaves appear on the stem at frequent intervals called nodes; the spaces between the groups of leaves or branches are called internodes. The arrangement of the branches follows that of the leaves, and is after one of two general plans. (8)

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(6) In this connection, study the woodbine and ivy, and notice their methods of climbing. Notice also the tendrils on squash vines, and explain why they are found there.

(7) You should make a careful study of the branching of all common trees to become familiar with the form of trunk of each. This can best be done during that portion of the year when the trees are free from leaves. Notice the different forms of trunk in the same species when the tree is in the forest and when it is situated in an open field. How do you account for this?

(8) "In trees the leaves and buds of which are opposite, the tendency will be to form twigs in two rows about at right angles to each

The shape of the body of the stem varies from cylindrical to oval, square, and triangular. Cut sections of a large number of stems and notice this variation in form.

Underground stems are usually covered with scales instead of leaves. (9) Many of these stems store up food for the growth of the plant the next season. The three most common forms of such stems are the rootstock, the tuber, and the bulb. (10)

Many peculiar forms of leaf-like stems are found in the dry regions. Here the stem seems to serve the double purpose of stem and leaf; the various species of cactus are good illustrations of this arrangement.

The structure of stems shows them to be made up of a variety of tissues. These are so arranged as to provide

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other along the sides of the branch. This arrangement will not usually be perfectly carried out, since some of the buds may never grow, or some may grow much faster than others and so make the plan of branching less evident than it would be if all grew alike.

"In trees like the beech the twigs will be found to be arranged in a more or less regular spiral about the branch. This, which is known as the alternate arrangement, is more commonly met with in trees and shrubs than the opposite arrangement. It admits of many varieties, since the spiral may wind more or less rapidly around the stem."

— Bergen's *Elements of Botany.*

(9) "Ordinarily subterranean stems send foliage-bearing branches above the surface, and such stems are not to be classed as foliage-bearing stems. But often the only stem possessed by the plant is subterranean, and no branches are sent to the surface. In such cases only foliage leaves appear above ground, and they come directly from the subterranean stem. The ordinary ferns furnish a conspicuous illustration of this habit." — Coulter's *Plant Relations.*

(10) "It is interesting to notice that nearly all the early-flowering herbs in temperate climates, like the crocus, the snowdrop, the spring-beauty, the tulip, and the skunk-cabbage, owe their early-blooming habit to richly stored underground stems of some kind, or to thick, fleshy roots." Bergen's *Elements of Botany.*

for the circulation of the sap, and by this means enable the nourishment taken in by the roots to be digested in the leaves and then carried to all parts of the plant. The greater part of the sap is water, in which the food is found in solution. (11)

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(11) "Cut some short branches from a grapevine and stand the lower end of each in red ink; try the same experiment with twigs of oak, ash, or other porous wood, and after some hours examine with a magnifying glass, successive cross-sections of one or more twigs of each kind. Note exactly the portions through which the ink has traveled. Repeat with several potatoes cut crosswise through the middle. For the sake of comparison between roots and stems, treat any convenient root, such as the parsnip, in the same way. What conclusion can be drawn from this experiment as to the course of the sap?"

— Bergen's *Elements of Botany.*

(11) "Cane sugar exists in great abundance in the cell sap of sugar-cane, maple, sugar-beet, Indian corn, and in a greater or less quantity in nearly all higher plants. Fruit sugar, as its name indicates, is found in many fruits, sometimes mixed with cane sugar; thus in grapes, cherries, gooseberries, and figs it is the only sugar present, while in apricots, peaches, pineapples, plums, and strawberries it is mixed with cane sugar."

— Bessey's *Botany.*

(11) The structure of stems corresponds with a number of very important functions performed by the elements that compose them. Thus the epidermis, afterward replaced by cork, is protective, as is also the bark, which on the trunks of most trees becomes greatly thickened with advancing age. The medullary rays and other parenchyma cells of wood and bark serve for storage of various food products, and are also employed to a considerable extent in conducting them from one part of the plant to another. Bast and wood fibers serve a special purpose as mechanical elements by which the stem is maintained in its position, and enabled to resist forces that tend to strain or fracture it. Finally, the vessels and tracheids are chiefly concerned in conducting water containing mineral substances and air from the roots to the upper parts of the plant, while the sieve-tubes of the inner bark store up nitrogenous food materials, and convey them to the points where they are needed.

— Spalding's *Introduction to Botany.*

The differences between exogenous and endogenous stems are important to recognize. The stem described in note 1 of this number is an exogenous stem. In the region (3) described as vascular, there are distributed in groups what are known as fibrovascular bundles. These bundles of cells are both fibrous and vascular, that is, they are long and thread-like and contain ducts which permit the flow of water through the plant. Each bundle is composed of two parts, soft bast or sieve tissue and a tissue of hard woody cells and ducts. The relative position these parts bear to each other is constant in different groups of plants, but to make the parts out requires closer study than can be given without a microscope. These fibrovascular bundles in the exogenous stem run through the whole length of the plant, extend into the branches, and form the framework of the leaves. As the stem grows older these bundles harden, and on the side of the ring next the pith becomes useless, the only place where they can be renewed being in the outer edge of the ring we are describing. Accordingly the stem grows by adding layer after layer on the outside. It is in this that the endogenous stem differs so materially, for in it the living fibrovascular bundles are not grouped in a ring around a central pith but occur irregularly throughout the stem. Moreover, the bundles are not parallel with each other and are not the same size throughout. If you cut through the cuticle and break a cornstalk, you will see the fibrous bundles scattered through the pith. This arrangement must mean that the growth of the stem is not confined to layers or zones, but that the whole stem is in a sense alive. In temperate regions there are no woody endogenous plants.

The cells which compose these bundles differ in shape, and under the microscope are found to be variously marked. Some are much elongated and placed end to end, and the walls are covered with spiral markings. The partitions between the ends of these cells break and then there are left long tubes or ducts leading through the stem; these are the vessels through which fluids rise from the roots. When water is plenty these cells are well filled, but when it is scanty the fluid is replaced by bubbles of gas.

Just how the water is drawn up through these cells is not perfectly understood. Doubtless many forces unite to accomplish it. The water absorbed through the roots will pass from cell to cell as the density of the contents varies, and so will find its way into and through the vascular system of the plant. This is a second process in circulation.

The water taken up by the roots is an actual food for the plant and forms a large portion of its tissue. Sometimes roots and underground stems are more than 90 per cent water.

With the exception of carbon and oxygen the elements that enter into plant tissues are obtained through the roots and are always in combination with other substances. The proportion of mineral matters in plants varies greatly as may be seen by burning plants and comparing the ash that remains.

The pith illustrates what is called parenchymatous tissue in which the cells are roundish, cubical or irregular in shape but not long and slender. When young and alive the cells are thin walled and contain much protoplasm, but as they grow older the cell walls thicken and harden,

and the protoplasm disappears. The dead pith of the corn stalk shows the tissue in this condition.

One of the most interesting phases of the study of botany is that of the ways in which plants are modified in order to suit the conditions under which they grow. A plant grows where it must, not where it wishes to grow; if conditions are not favorable it must meet and overcome them or perish. While the tuber is a device by one plant, others in dry regions have developed short, thickened, fleshy stems, with dense, polished, cuticle-bearing spines and hairs instead of leaves. Whatever moisture the plant can get from the soil is jealously guarded from evaporation, and the spines protect the plant against animals that might enjoy the succulent stem. Whenever we see these wonderful adaptations we are led to inquire how they came about. A number of seeds find their way into a region new to them and germinate. Only the strongest of these, those best adapted to their environment, will mature. The fittest will survive. Any little peculiarity that helped them along will tend to be transmitted to the next generation, from which the unfit will perish.

STUDIES.

1. Why should underground stems have scales instead of leaves?

2. Does a twining plant save any force by its habit?

3. What advantages do some plants gain by blooming early?

4. Are early-blooming herbs rapid in maturing fruit?

5. Does the same tract of land produce different sets of native plants at different seasons of the year? Can you not watch some wild tract a season through and note the changes in the plants that populate it?

ZOOLOGY

ZOOLOGY.

The Arthropoda, or joint-legged animals, are more numerous than those of any other branch of the animal kingdom. They occupy a higher position in the scale of being than the Mollusca. Those have a soft body protected by a hard shell; these have a jointed external skeleton. For this reason they are known in the older classifications as Articulata, or jointed animals. They are classified into two great groups: Crustaceans, and Insects.

Many representatives of crustaceans are found in both fresh and salt water. (1) The crawfish, or crayfish, furnishes the most convenient type for study. (2) The lobster is his salt-water cousin.

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(1) "To this group belong those segmented animals which have jointed appendages; i. e., antennæ, jaws, maxillæ (or accessory jaws), palpi, and legs arranged in pairs, the two halves of the body thus being more plainly symmetrical than in the lower animals. The skin is usually hardened by the deposition of salts, mostly carbonate of lime, and of a peculiar organic substance called *chitin*. The segments or rings composing the body are usually limited in number, there being usually twenty in crustaceans and seventeen or eighteen in most insects, though in the myriapods there may be as many as two hundred. The head is usually distinct from the body, with one (in insects) or two (in crustaceans) pairs of feelers (antennæ), from two to four pairs of biting mouth-parts or jaws, and two compound eyes (except in spiders, etc.), besides simple eyes. Most arthropods pass through a series of changes of form called a metamorphosis; the young of the butterfly being called a caterpillar or larva, the succeeding stage a pupa or chrysalis, and the mature stage the imago." —Packard's *Zoology*.

(2) "In warm weather this animal may be found crawling upon the bottom of brooks and natural ponds. The largest specimens will be found in creeks and in ponds which are not dried out during the summer. A water net will be of service in securing specimens."

—Needham's *Elementary Lessons in Zoology*.

The most numerous class of the animal kingdom is that of insects. The present classification includes about 200,000 species, and there are numerous species yet unclassified.

Many common insects serve as types from which to study the class. The May beetle or June bug, the dragonfly, the grasshopper, and the butterfly are all good specimens for this purpose, as they are large and their parts can be readily seen. As the general structure of all insects is on the same plan, the study of any good type will give an intelligent idea of all. (3)

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(2) "Live specimens may be kept for a long time in any sort of an aquarium supplied with food. They eat snails and insects greedily, and live on almost any kind of flesh.

"Startle a crawfish at rest upon the mud, and observe the cloud it raises in the water, behind which to escape.

"Watch a crawfish walking about in an aquarium, and see how many feet it walks with, and in what order they are moved.

"Startle it by thrusting a stick toward its eyes, and see its rapid locomotion backward. How is this effected?

"Observe its feeding habits.

"Place a live crawfish in a small dish, and barely cover it with water. Take hold of its body with forceps, and observe its way of defending itself. Observe that its eyes are stalked and capable of protrusion outward." — Needham's *Elementary Lessons in Zoology.*

(3) "In insects the head is separated from the rest of the body, which is divided into three regions, the head, thorax, and hind-body (abdomen); hence the name insect, from *insectum*, cut into, or divided. Insects breathe by internal air-tubes which open through breathing-holes (spiracles) in the sides of the body. The six-footed insects also have two pairs of wings.

"The number of body segments in winged insects is seventeen or eighteen; i. e., four in the head, three in the thorax, and ten or eleven in the hind-body. In spiders and mites there are usually but two segments in the head, four in the thorax, and a varying number (not more than twelve) in the abdomen; in myriapods the number of segments varies greatly; i. e., from ten to two hundred. The appendages of the body are jointed.

To obtain a knowledge of their habits, insects should be studied while alive; and by dissection to obtain a knowledge of their structure. The study should include the most common species. Suitable apparatus is needed for collecting and preserving specimens. (4)

"Of winged insects there are two types: first, those in which the jaws and maxillæ are free, adapted for biting, as in the locust and grasshopper; and, second, those in which the jaws and maxillæ are more or less modified to suck or lap up liquid food, as in the butterfly, bee, and bug." —Packard's *Zoology*.

(4) A net for collecting insects can be made in the following manner: Take a stiff wire ring about ten inches in diameter, and fasten it firmly to a broom handle. To this ring sew a conical-shaped net made of mosquito netting; a piece a yard square will be ample for the purpose. A little practice will enable you to capture any specimen desired.

Provide a cyanide bottle for killing specimens, by taking a wide-mouthed bottle or pint fruit-can, and placing in it a half-ounce of cyanide of potassium. The crystals should be broken into small pieces and just covered with water. Place enough plaster of Paris in the jar to absorb all the water, and form a hard mass over the cyanide crystals. If plaster of Paris is not at hand, clean, fine sand can be used. Keep the bottle tightly corked, mark it "*POISON*," and keep it where it will be out of reach of children. The fumes of cyanide are very poisonous, and should not be inhaled.

(4) "In collecting observe the following rules: —

1. Collect no more specimens than will probably be used.

2. Get for preservation the finest specimens obtainable, and preserve them with the utmost care.

3. Keep live specimens supplied with water, food, and fresh air.

4. Make each collecting trip an opportunity for studying animal life under natural conditions. Make note of the haunts of each animal, of its animal associates, of its food, of its shelter, of its natural enemies, of its home,— in short, of the life it leads.

5. Remember that fear is inherent in most animals, and that flashy colors, loud noises, and quick and careless movements will frighten them, and cause the loss of opportunities for observation. Hence wear quiet colors, avoid noise, avoid haste, and keep your eyes wide open." —Needham's *Elementary Lessons in Zoology*.

Insects can be classified in various ways, such as those injurious to agriculture and those beneficial to it; those having a mouth constructed for biting, like the beetle, and those having a mouth constructed for sucking, like the butterfly. Naturalists, however, classify them into several great groups or families, basing their distinctions largely upon the form and structure of the wings and habits of life. (5)

The organization of insects is even more complete than that of crustaceans. They are symmetrically developed, and possess complete circulatory and nervous systems. (6)

(5) The most commonly accepted classification divides insects into the following families: The Coleoptera, or sheathed-winged, like beetles, as the May beetle, Colorado beetle, etc.; the Neuroptera, or nerve-winged, like the dragon fly, white ant, ant-lion, etc.; the Orthoptera, or straight-winged, like the grasshopper, locust, katydid, etc.; the Hemiptera, or half-winged, like the cicada, squash bug, chinch bug, bed bug, plant lice, etc.; the Diptera, or two-winged, like the common fly, mosquito, flea, etc.; the Lepidoptera, or scaly-winged, like the butterfly, moth, etc.; the Hymenoptera, or membrane-winged, like bees, wasps, ants, etc.; the Myriapoda, or many-legged, like centipedes; the Arachnida, or spiders, etc.

—Adapted from Burnet's *School Zoology*.

(6) The food of insects is so various that diverse organs are necessary for seizing it and preparing it for digestion. The mouth parts normally present are a labrum; a pair of mandibles; a pair of maxillæ, each with three appendages; and a labium with its jointed palpi. Any of these parts may be specialized, modified, or suppressed according to the needs of the animal.

Digestion is effected by the crop (when present), gizzard, and stomach, aided by secretions from salivary glands and gastric cæca.

Circulation is effected at first by the passage of the digested food through the walls of the alimentary canal, out into the blood. The blood bathes all the internal organs, taking to each the material needed for cell construction.

Respiration is effected either by spiracles or by tracheal gills. The former are adapted for aërial, and the latter for aquatic respiration.

The common gray grasshopper is found by every roadside, and is a good type to study. (7)

The spiracles are situated on the sides of the body, and open into tracheæ, which unite into longitudinal trunks, and send their numerous branches to every vascular part of the body.

Assimilation of food is the business of each individual cell, as is also excretion.

All insects are diœcious; i. e., the sexes are distinct. Paired generative organs are found in the abdomen beneath the dorsal vessels. Nearly all insects are produced from eggs.

There are two general types of metamorphosis: 1. When incomplete, there emerges from the egg a nymph which differs from the adult principally in size, and which, when grown, transforms directly into a perfect insect. 2. When complete, the egg produces a larva, usually a little worm-like creature with little external likeness to its parents. This, when grown, transforms into a pupa, which, after a quiescent period, again transforms, when an imago issues.

—Adapted from Needham's *Elementary Lessons in Zoology.*

(7) 1. The head: Notice its shape and mode of attachment to the thorax. Observe the antennæ; how and where they are attached to the head; count the parts or segments. (Use the lens for this.) Note the situation and shape of the eyes; these are compound, and each of the parts is called a facet. In front of the compound eyes look for a pair of simple eyes, the ocelli. Find a third ocellus, using a lens if necessary. The movable flap at lower part of the front of the head is the upper lip, or labrum; raise it with the dissecting needle. This will lay bare the jaws or mandibles. Study their action in a live grasshopper. Back of the mandibles is a brown tongue. By further examination find the labial palpi, and smaller pair of jaws called the maxillæ.

2. The thorax: The wide collar, or cape, back of the head is the prothorax. The remainder of the thorax is formed by the union of two parts, each bearing a pair of legs. Just above the second pair of legs find the spiracle by noticing its opening and closing in a live specimen.

3. The wings: Notice the position of the outer wings and their mode of overlapping. The framework is composed of veins. Compare the inner and outer wings in (a) size, (b) shape, (c) color, (d) texture, (e) position both when at rest and in motion, (f) use.

4. The legs: Note the number, arrangement, and mode of attachment. Study carefully one of the hind legs.

After a similar plan, study the abdomen and internal structure.

—Adapted from Colton's *Practical Zoology.*

The study of insects introduces us to a department of zoology containing an abundance of material, more or less of which is always at hand. Insects are everywhere, and in addition to the special line of study already indicated in this number, you should become acquainted with them in a general way.

The homes of many insects are very interesting. The nest of the carpenter bee is frequently found in the dead limbs of trees. This bee bores a tube which follows the grain of the wood for several inches. The tube is divided into several cells, each cell containing an egg, and sufficient food for the larva. The partitions between the cells are made from the sawdust obtained in boring.

A spider's web when examined with a good glass, shows wonderful symmetry and strength. Place the foot of a large spider under the glass, and notice the peculiar structure of the claw which enables the little creature to run so nimbly over the web. The eggs of most spiders are inclosed in a silk cocoon.

The tarantula, or trap-door spider, digs a hole in the ground from two to three inches deep. The hole is lined with silk, and covered with a closely fitting lid, which is held in place by a silken hinge.

The water spider constructs a bell-shaped cocoon of silk under the water, and attaches it to leaves or twigs. As the spider is an air-breathing animal, its young must be supplied with air. The water spider supplies this in a peculiar manner. She floats upon the surface until in some peculiar way a bubble of air forms on her abdomen; this she holds in place by the long hairs on her body, and quickly diving beneath the cocoon releases it. The air rises into the bell-shaped cup formed by the cocoon.

The above illustrations are sufficient to indicate what you should look for in a general way in your study of insects; each discovery will lead to others of greater interest. One need have no fear nor hesitation about handling most insects; with the exception of spiders and bees, one may handle all insects of our latitude with impunity, for they are perfectly harmless. In handling larvæ of large moths and butterflies, care should be taken not to get bitten, as the bite may produce a sore that does not readily heal.

Branch VII. Arthropoda, includes six classes, as follows:

Class I. Crustacea. Lobster, crab, etc.

Class II. Podostomata. King crab.

Class VI. Insecta. Insects.

Classes IV and V, include centipedes and spiders respectively, and Class III is of no interest to the general student.

The king or horseshoe crab of Class II is one of the most peculiar animals found in the sea. The body contains nine segments, the last of which is lengthened so as to form a pointed spine resembling a tail. The entire body is covered with a jelly-like shield shaped like the hoof of a horse on the upper side, and like a horseshoe on the under side. This crab obtains its food by digging in the sand and mud. It attains quite a large size, some specimens being two feet in length. The tissues contain a large proportion of water, and when dried a specimen weighs only a few ounces.

Learn this table, then try to write the three in order from memory. If you fail, review and practice until you can write the classification correctly as far as learned.

STUDIES.

1. Place a common house fly under a magnifying glass, and study its structure. Notice the two brown lobes on each side of its head; if the glass is one of good power, these will present a rough surface. When a section of one of these lobes is placed under the compound microscope, we find it to be made up of numerous six-sided facets, each facet is a tiny lens, and constitutes an eye. The fly has over four thousand of these eyes. The dragon fly has even a greater number. By this arrangement these insects can see in all directions without moving the head or body.

2. Take a careful look at the wings, and notice their delicate and systematic structure. Place a drop of milk or molasses under the glass where it will attract a fly, and study its manner of eating. The food is sucked through the tongue.

3. Try to discover what arrangement enables the fly to walk up a vertical surface, or upon the ceiling.

4. The leg of a May beetle placed under your magnifying glass will be enlarged enough to show the structure of the foot. After studying the foot, watch a beetle and see what use it makes of each part. Why can these beetles cling to anything so tenaciously? Similar studies of other common insects will reveal many interesting facts.

5. Compare the two pairs of wings on the May beetle and notice the difference in their structure.

6. Compare the wings of a butterfly or moth with those of the beetle; with those of the fly.

PHYSICS

PHYSICS.

MOTION AND FORCE. (CONTINUED.)

Curvilinear motion. A body moving over a curved path changes its direction at every point. Its resistance to this change of direction produces a stress upon the force that confines the body to its path. The path then is the resultant of two forces, one of which would project the body in a straight line and the other would draw it to the center of the curve through which it moves. When these two forces are constant, the body moves in a circle. If one is constant and the other instantaneous, the body moves in a curve, but no successive parts of this curve are arcs of the same circle. A weight attached to a string and whirled about the hand is a good illustration of motion in a circle, while the path taken by a body thrown horizontally or slightly upward is a good illustration of motion in a curve.

Experiment 23. Perform Experiment 3, *Instruction Book IX*, page 78.

Experiment 24. Tie a ball or some other weight to a string about 3 feet long. Take this out of doors and whirl it rapidly. When the ball is at the lowest point in its path, let go of the string. What becomes of the ball?

Centrifugal force is the resistance which the moving body offers to the force that compels it to move in a curved path.

Let r equal the radius, and centrifugal force (Fc) may be found by the following formula:

$$Fc = \frac{mv^2}{r}$$

From this formula the following laws are derived:

1. *The centrifugal force varies directly as the mass.*

2. *The centrifugal force varies directly as the square of the velocity, the radius being constant.*

3. *The centrifugal force varies inversely as the radius, the velocity being constant.*

Illustrations of centrifugal force are very common. Mud flying from a rapidly revolving carriage wheel, the tendency of carriages to upset when driven around a curve at a high rate of speed, the inclination of circus riders toward the center of the ring, are a few illustrations which you will readily recall. Think of others.

Why is the outer rail on the curve of a railway track elevated?

On what principle is a boy's sling worked? Why can he throw a stone with the sling farther than with the hand?

Upon what principle is the ordinary cream separator constructed?

GRAVITATION.

Acceleration. When a body moves with an increasing velocity, its motion is said to be *accelerated.* Acceleration is due to the operation of a constant force. Let a represent the constant acceleration, and we have

$$v=at;\ a=\frac{v}{t};\ t=\frac{v}{a}$$

Since $v=0$ before the force is applied,

$$s=\tfrac{1}{2}\,at\times t;\ \text{or}\ s=\tfrac{1}{2}\,at^2;$$

$$a=\frac{2s}{t^2};\quad t=\sqrt{\frac{2s}{a}}.$$

Substituting v for at, we have $s = \frac{v^2}{2a}$, from which we derive $v = \sqrt{2as}$.

Study these formulas carefully.

Gravitation is the mutual attraction between all bodies.

Gravity is the attraction which the earth exerts upon bodies on or near the surface.

The Law of Gravitation. *Every particle of matter in the universe attracts every other particle with a force directly proportionate to its mass, and diminishing in proportion to the square of the distance between the particles.*

Weight is the measure of gravity. In other words, weight is the measure of the earth's attraction for bodies. Since the polar diameter of the earth is less than the equatorial diameter, and since the centrifugal force is greatest at the equator and nothing at the poles, the weight of a body increases as it moves from the equator toward either pole. Therefore, a unit of weight is not an absolute standard.

Weight is greatest at the surface of the earth. If a body is removed to the summit of a high mountain, or taken up in a balloon, the weight decreases according to the following formula: Let W represent the weight at the surface, w the weight at the distance above the surface, D the distance from the center to the surface of the earth, and d the distance of the body from the center.

$$W : w :: d^2 : D^2$$

$D = 4{,}000$ miles.

A body weighs 1,000 lb. at the surface of the earth; what will it weigh 1,000 miles above the surface?

Solution:

$$4{,}000+1{,}000=5{,}000$$
$$1{,}000 : x :: 5{,}000^2 : 4{,}000^2$$
$$5{,}000^2 \times x = 4{,}000^2 \times 1{,}000$$
$$25x = 16{,}000$$
$$x = 640$$

Therefore the weight is 640 pounds.

The weight of a body below the surface of the earth decreases in a different ratio Numerous experiments and calculations have demonstrated that the rate of decrease is proportional to the distance below the surface. Therefore, we have this proportion:

$$W : w :: D : d.$$

A body weighs 1,000 lb. on the earth's surface. What will it weigh 500 miles below the surface?

Gravity attracts bodies toward the center of the earth, and all bodies not properly supported have a tendency to fall in that direction. The path described by a falling body is therefore a vertical line. This is usually known as a plumb line, from the lead weight used by carpenters and masons.

Experiment 25. Suspend one of the cans of sand by a string 5 or 6 feet long, so that the string will be 6 inches from the wall at the point of suspension. When the weight has ceased to sway, measure the distance of the lower end of the line from the wall. This is a plumb line. Is the wall vertical? How can you tell?

The center of gravity of a body is the point upon which it may be perfectly balanced. Center of gravity is often called *center of mass*. Can you explain why? It is also called *center of inertia*.

Experiment 26. Cut a board to correspond in shape with Fig. 4. Make a plumb line about 3 feet long and chalk the line; with a brad or wire nail bore holes at A and B. Make the holes large

enough so that the board will revolve freely about its point of support. Tie one end of the line to the awl or nail and suspend the board from A. When the line comes to rest, hold it firmly on the board and snap it. This will form a chalk line on the board. Suspend the board from B and repeat the operation. The lines thus found should correspond to AF and BG. Bore a hole through the board at the point where these lines cross. If your work has been carefully done, the hole passes through the center of gravity. Suspend the board on the awl as an axis and see if it will balance. Repeat the experiment with objects of different shape.

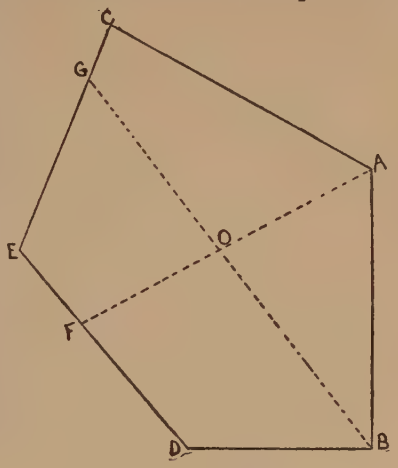


FIG. 4

Sometimes, as in the case of a ring, the center of equilibrium is without the body.

Equilibrium. A body is in equilibrium when it is in a state of rest; in other words, when the resultant of all the forces acting upon it is zero. The position of the center of gravity in bodies gives rise to three states of equilibrium: stable, unstable and indifferent.

A body is in *stable equilibrium* when a plumb line passing through its center of gravity falls within the base. In such a body the center of gravity must be raised before the body can be overturned. Household utensils are generally so shaped as to have stable equilibrium.

A body is in *unstable equilibrium* when a vertical line passing through its center of gravity falls without the base, or just within the base. In the first case the body

will fall over; in the second it can be overturned with very little effort. A ruler standing on one end is in unstable equilibrium. A box balanced on one corner is another good illustration.

A body is in *indifferent equilibrium* when the center of gravity coincides with the point of support, or when any movement neither raises nor lowers its center of gravity. A ball, and a joint of stovepipe lying on its side are good illustrations.

A suspended body is in stable equilibrium when the center of gravity is below the point of support.

Experiment 27. Take the lath that you used with the marbles and fasten a weight to one end and suspend the lath from the hole through its center. Try to revolve it about its point of support. By adding the weight you have lowered the center of gravity.

Experiment 28. Take a bottle at least 5 inches high. Insert a fine sewing needle in the cork and push it up from the lower end so that when the cork is inserted in the bottle the point of the needle will be at least a half inch above its upper end. Take a piece of soft pine about a half inch square and 3 inches long. Drive a pin into the center of one end so that the head will be left at least a half inch from the end of the stick. Take two pocket knives of about equal weight, or two table forks, and stick them into opposite sides of the pine about midway between the ends. Stick them in a slanting direction so that their handles will project some distance beyond the head of the pin. Be sure to push their points into the wood far enough to make them secure in their position. Place the end of your finger under the head of the pin and lift the apparatus; balance it by placing the side of the pin on the point of the needle. If your work is carefully done, the apparatus will revolve about its point of suspension in a very interesting manner. Where is the center of gravity?

FALLING BODIES.

Since the force of gravity is constant, falling bodies afford the best illustration of uniformly accelerated motion.

Experiment 29. Take a piece of paper about 2 inches square, and a nail. Hold them between the thumb and forefinger as high as you can reach, and drop them. Which reaches the floor first? Now make the paper into a compact wad and repeat the experiment. What change do you notice?

Under the constant influence of gravity alone all bodies fall with equal rapidity.

In the first part of Experiment 29 the paper fell more slowly than the nail, on account of the resistance of the air. When this was removed, by making the paper into a wad, both fell with equal rapidity.

Repeated experiments have proved the following laws of falling bodies:

1. *Under the influence of gravity alone, a freely falling body acquires a velocity of 32.16 ft., or 980 cm., in one second.*

$$v=32.16t \quad \text{or,} \quad v=980t$$
$$v=at \qquad\qquad v=at$$

2. *Under the influence of gravity alone a body falls the first second 16.08 feet, or 490 cm.*

$$s=16.08\ (2t-1) \quad \text{or,} \quad s=490 \text{ cm. } (2t-1)$$

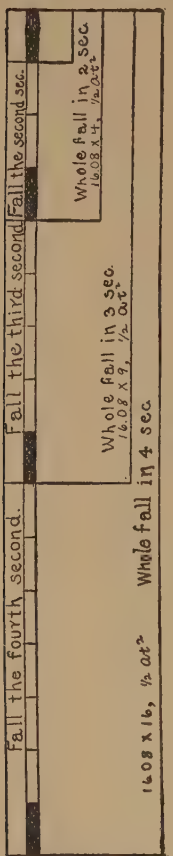
3. *The entire distance a body falls in a given time is equal to the distance it falls the first second multiplied by the square of the number of seconds.*

$$S=32.16\ (\tfrac{1}{2}at^2) \quad \text{or,} \quad S=980\ (\tfrac{1}{2}at^2)$$
$$S=16.08t^2 \qquad\qquad S=490t^2$$

A study of Fig. 5 will help you to understand these laws. The shaded spaces indicate the distance added each second by gravity.

The velocity of a body until it begins to fall is zero. Let the distance it falls the first second represent one space s. If measured in feet, $s=16.08$; if in cm., 490.

Gravity has given it a velocity equal to twice the space it falls; that is, 32.16 ft. or 980 cm. Were the force of gravity suspended at the end of the second, the velocity which the body has acquired would carry it two spaces the next second, but gravity gives it a uniform increase of velocity each second. This will cause it to fall an additional space, making in all three spaces that it will pass over during the second second, which is equal to the distance it falls the first second multiplied by twice the number of seconds less one.


Fall the fourth second.
Fall the third second.
Fall the second sec.
Whole fall in 2 sec.
16.08 x 4, ½ at²
Whole fall in 3 sec.
16.08 x 9, ½ at²
16.08 x 16, ½ at²
Whole fall in 4 sec
FIG. 5

Since the body falls 1 space the first second and 3 the second, during the two seconds it falls 4 spaces, which is equal to the distance it falls the first second multiplied by the square of the time.

At the beginning of the third second the body has a velocity of 4 spaces, and gravity adds one more, making 5 spaces that it falls the third second. For similar reasons it falls 7 spaces the fourth second, 9 the fifth and so on.

During the first two seconds the body falls 4 spaces, which added to the 5 spaces it falls the third second, makes 9 spaces for the three seconds. To this add the 7 spaces it falls the fourth second, and we have 16 spaces for the entire distance it falls during four seconds. In each case the entire number of spaces it falls (S) is equal to the square of the number of seconds.

Since the acceleration is due to gravity, let g represent a, then $g=2s$. At the end of the first second, $v=g$; at the end of the second second, $v=2g$; at the end of the third, $v=3g$, and so on; $g=32.16$ feet, or 980 cm.

This study should enable you to deduce the following rules for computing the data of falling bodies:

1. To find the entire distance a body falls in a given time:

Multiply 16.08 ft., or 490 cm., by the square of the number of seconds, according as the result is required in feet or meters.

2. To find the distance a body falls any given second:

Multiply the distance it falls the first second by twice the number of seconds less one. $[\frac{1}{2}g\,(2t-1)]$

3. To find the velocity of a falling body at any given second:

Multiply the velocity at the end of the first second, 32.16 ft., or 980 cm., by the number of the second.

You should study these formulas, the diagram and the explanations until you perfectly understand them. The laws of falling bodies afford a new field for the application of a few ordinary mathematical principles, and this new feature occasionally causes students to become confused, when the problems are very easy of solution.

The laws of falling bodies apply in reverse order when a body is thrown upward. In computing the data for bodies thrown upward, remember that it takes the body as long to rise as it does to fall, so divide the time it is in the air by two.

Experiment 30. Take a board 6 or 8 inches wide and 16 feet long, and planed on at least one side. Mark the planed surface off into spaces 1 foot long by drawing heavy lines across the board. Ele-

vate one end of the board 1 foot, taking care to so adjust it that it does not slant towards one edge. Place a marble at the upper end of the board and allow it to roll to the bottom. What is the time required for its descent? How many spaces does it pass over in each second?

You can approximately verify the laws of falling bodies by this simple device. If you have a text-book containing a description of Atwood's machine, study the description in connection with this experiment.

PROBLEMS.

Solve and send in with your recitation paper:

1. A body falls 5 seconds.
   (*a*) How far does it fall?
   (*b*) With what velocity does it strike?
   (*c*) How far does it fall the fourth second?

2. A boy wishing to ascertain the height of a steeple shoots an arrow upward which just reaches the top of the steeple. The arrow was in the air 6 seconds. How high was the steeple?

3. A body struck with a velocity of 6,860 cm. How far did it fall?

4. A body weighing 5 pounds was dropped from a vertical cliff 1,029 feet high. With what momentum did it strike the earth?

5. A body is thrown upward with a velocity of 4,900 cm. How high does it rise?

COMPOSITION AND RHETORIC

COMPOSITION AND RHETORIC.

We do not think in fragments, our thoughts are complete. Hence we express our ideas not in mere disconnected words, but in unified combinations of words. It is not enough, then, to know the value of words in themselves; the really important thing is to learn how to combine them. The first step in this putting together or composition of words is the sentence. It is the expression of one complete idea. In its very simplest form, the sentence consists of two words, a subject, or that about which something is to be told, and a predicate, that which tells something about the subject. These are the elements *essential* to every sentence. But it is often necessary to modify or complete their meaning; hence either or both may be expanded by adjuncts in the form of simple words or phrases or clauses.

The relations and the general arrangement of these various elements of a sentence are governed by rules which have been fixed by centuries of good use, and may never be violated by those who wish to use correct English. These are the rules of grammar, and as such lie outside of the scope of rhetoric. There are, however, a number of common faults in grammatical construction which must be carefully noted and corrected before clear, forcible, and pleasing sentences can be made.

SOLECISMS.

A solecism, like an impropriety, is the misuse of a term. The misuse, however, does not lie in the meaning of the word, but in the relation of the word to others in

the same sentence. Thus, in the sentence, "I will not go *without* I get her consent," *without* is not incorrect because of its meaning, but because of its relation to what follows. It is a preposition and therefore can not introduce a clause. That its meaning is not at fault may be shown by substituting for the clause, a phrase: "I will not go *without* getting her consent."

Note carefully the nature of the misuse in the following solecisms and correct the sentences:

1. Wrong agreement in number of subject and verb.

"Either you or your brother *are* in the wrong."

"There *seems* to have been several causes for the disaster."

Remember that singular subjects connected by or; either — or; neither — nor; require a singular verb.

2. False agreement of a pronoun and its antecedent.

"The constitution says that no *person* shall be deprived of *their* rights."

"The *child* may not now understand the cause of what *it* learns but *he* will grasp it sometime."

3. Change in the tense of the verb from past to present or vice versa in the same sentence.

"As the wagon *rounded* the corner, up *jumps* Henry and *runs* toward it."

"The villain *laughs* bitterly, and then the curtain *fell*."

4. Use of the perfect infinitive for the present infinitive.

"He seemed yesterday *to have been greatly excited*."

"They say that you promised *to have written sooner*."

Unless the time expressed by the infinitive is earlier than that of the main verb, the present infinitive is to be used.

5. *Which* used to refer to a clause or sentence. It can refer only to a noun or pronoun.

"The monks preserved hundreds of ancient manuscripts; *which* has been of inestimable importance in furthering the progress of thought."

"It is good that he has turned over a new leaf, *which* he certainly ought to do."

Here *which* points back to all that precedes.

6. *And which*, *and who*, *and when*, and similar expressions used where the *and* is superfluous.

"We found a few plants of unusual appearance *and which* apparently do not grow abundantly in this region."

"He jumped down from his position of defense *and when* he was most needed."

7. Obscure reference of pronouns.

"The professor told John that *he* needed a vacation."

"The plot of this story is engrossing; it is hard to determine however, whether *it* is the work of an amateur or of a skilled writer."

To what do the italicized words refer? Repeat the pronoun if its relation is not clear, or recast the sentence.

8. Errors in the case of pronouns.

"These tickets are for her and *I*."

"*Whom* did it seem to be?"

9. The cleft infinitive.

"It is not his intention *to deliberately accuse* them."

"*To rightly understand* the statement, read the note of explanation."

Good writers do not place an adverb between the sign *to* and the verb of the infinitive, except where harmony positively demands it.

10. The omission of the article before names of things distinct.

"The *captain* and *umpire* left the field."

"The *author* and *musician* were equally honored."

In neither of the above sentences do the italicized words indicate the same person.

11. Adverb for adjective, and vice versa.

"She played *beautiful*."

"He looks *miserably*."

12. The use of the double negative for simple negation.

"I *can't* see *no* reason for it."

"He *don't* think *nothing* of their remarks."

13. The use of the perfect participle for the simple past tense.

"I *done* it before I *come*."

"The child *run* to his father as soon as he *seen* him."

14. Use of the past tense for the perfect participle.

"The traveler *had went* many miles before the storm overtook him."

"If we *had saw* you before, we could have warned you."

15. Use of the possessive case of nouns which name inanimate objects, instead of the prepositional phrase introduced by *of*.

"No one can estimate that *college's* influence on the city in which it is situated."

"This *country's* exports are remarkably varied."

Specific errors.

1. *Such—which* used for *such—as*.

"He was guilty of *such* thefts *which* I shall not try to describe."

2. After *than* or *as*, introducing a clause of comparison, the objective case is sometimes used for the nominative case of the pronoun.

"Are the rest of the family as talented as *him*?"

3. *But what* used for *but that*.

"You do not know *but what* you will meet the same difficulty."

4. The personal pronoun *them* used for the demonstrative pronoun *those*.

"Irving didn't write *them* stories."

5. *If* for *whether*. If introduces a condition; whether introduces alternatives.

"A great general must be daring; he can not always tell *if* he is acting for the best or not."

6. *Either* used to refer to more than two things.

"That country has suffered every year *either* from war, or pestilence, or a financial crisis."

7. *Don't* used instead of *doesn't*, in the third person singular number.

"It *don't* matter how long you stay."

8. *Without* put for *unless*.

"Cuba could not have become independent *without* the United States gave her aid."

9. *Equally as — as* used for *equally — as*.

"Some of the slaves in ancient times were *equally as* well educated *as* their masters."

Obviously the first *as* is superfluous.

10. *As* used for *that*.

"I don't know *as* our course is to be justified."

After we have learned to make sentences thoroughly grammatical, we are ready to consider the means of making them *effective*.

Questions as to length and forms of sentences arise, and can be answered not by an outside, arbitrary authority, such as good use in grammar, but by the judgment of the writer, according to the needs of the particular case. The following general considerations may direct in any given instance.

PRINCIPLES RELATING TO LENGTH AND STRUCTURE OF SENTENCES.

I. The short and the long sentence.

1. The short sentence is well adapted for simple, direct thought. It economizes the reader's attention and thus gives rapidity and vigor to expression. A succession of short sentences, however, has a tendency to produce a jerky and monotonous effect. Do the short sentences make the following selection forcible, or is there an unpleasant lack of smoothness?

"The darkness was bewildering. Man requires light. Whoever buries himself in the opposite of it feels his heart contract. When the eye sees black, the heart sees trouble. In an eclipse in the night, in the sooty opacity, there is anxiety even for the stoutest hearts. No one walks alone in the forest at night without trembling. Shadows and trees—two formidable densities. A chimerical reality appears in the indistinct depths." —Hugo's *Les Misérables*.

2. The long sentence is well suited for involved thought. It binds all the modifications of an idea together in a single unit and makes their relations evident, but unless it is skillfully handled it becomes clumsy and confused, and does not lay stress upon the important part

of the thought. Note the perfectly clear and symmetrical structure of the following unusually long sentence:

"The scene is often profoundly oppressive, even at this time, when every plot of higher ground bears some fragment of fair building; but in order to know what it was once, let the traveler follow in his boat at evening the windings of some unfrequented channel, far into the midst of the melancholy plain; let him remove, in his imagination, the brightness of the great city that still extends itself in the distance, and the walls and towers from the isles that are seen; and so wait, until the bright investiture and sweet warmth of the sunset are withdrawn from the waters, and the black desert of bare shore lies in its nakedness beneath the night, pathless, comfortless, infirm, lost in dark languor and fearful silence, except where the salt runlets plash into the tideless pools or the sea birds flit over their margins with a questioning cry; and he will be enabled to enter in some sort into the horror of heart with which this solitude was chosen by man for his habitation."

—Ruskin's *Stones of Venice.*

Neither the short nor the long sentence should be used exclusively. Variety in length, where possible, produces a happy effect, for the short sentence lends life to the slow movement of the long sentence, and this in turn contributes dignity. The inexperienced writer will do well, however, to use the long sentence sparingly until skill in constructing it has been developed.

II. The periodic and the loose sentence.

1. A periodic sentence is one in which the thought and the grammatical structure end together. The modifiers and principal elements are so arranged that the reader does not get the full meaning until he reads the last words. By this suspension of the sense, attention is firmly held until the point is made. Vigor and compactness are then the advantages of periodic structure. The

danger in its use lies in holding back the thought so long that the reader becomes wearied; or in lending a stiff, formal air to simple discourse.

Notice that the modifiers are placed first in the two following periodic sentences, and the essential elements last, or near the end:

"Once upon a time, it matters little when, and in stalwart England, it matters little where, a fierce battle was fought."

"In one of the most remote districts of the south of Scotland, where an ideal line, drawn along the tops of lofty and bleak mountains, separates that land from her sister kingdom, a young man called Halbert, or Hobbie Elliot, a substantial farmer who boasted his descent from old Martin Elliot of the Preakin Tower, noted in Border story and song, was on his return from deer stalking."

Another way of building up a periodic sentence is to use correlatives, such as neither-nor, both-and, as (or so) -as; and subordinate conjunctions such as while, since, if. In the following sentences notice how loose structure is converted into periodic by the introduction of such expressions:

"George the Third would not satisfy the claims of his American colonists, nor would he respect the rights of his British subjects." (Loose form.)

"George the Third would neither satisfy the claims of his American colonists nor respect the rights of his British subjects." (Periodic form.)

"The green-carpeted expanse of prairie can never appear beautiful to his eyes; but the bleak, rugged heights of his native mountains impress him powerfully." (Loose form.)

"Although the green-carpeted expanse of prairie can never appear beautiful to his eyes, the bleak, rugged heights of his native mountains powerfully impress him." (Periodic form.)

2. The loose sentence may be broken off at one or more places before the end without making the structure grammatically incomplete. It is easy and natural, and especially well adapted to simple or familiar discourse. Unless care is used, however, the loose sentence is apt to become a mere incoherent succession of trailing phrases and clauses which produce an effect of weakness and seem to indicate careless thinking.

Is the loose structure of the following agreeable or otherwise? How could you make these sentences periodic?

"Monseigneur Bienvenu was simply a man who took note of the exterior of mysterious questions without scrutinizing them, and without troubling his own mind with them, and who cherished in his own soul a great respect for darkness."

"The sun is up and sparkles along the valley, tipping the transparent foliage of the groves. The matin bells resound melodiously through the pure, bright air, announcing the hour of devotion."

3. Variety in structure is desirable. It is equally true of the form of sentences as of their length: Do not confine yourself to either kind of structure. In general, it is well to cultivate especially the use of periodic structure, since it is the less familiar of the two and aids powerfully in strengthening style.

The worth of all the preceding principles is realized only through actual composition. Practice—constant, careful, willing practice—gives the study of rhetoric its real value; it enables the student not only to create a form for his own ideas, but to appreciate far more fully the thought and expression of the masters.

STUDIES.

I.

Write a paragraph explaining fully the nature of solecisms and the importance of guarding against them in composition. To make sure that you understand in what consists the error of each of the first fifteen solecisms, give one further example of each and correct the error.

II.

Look up very carefully the difference in use and meaning of *shall* and *will*, *can* and *may*. How are they frequently misused? Tell in writing why punctuation is essential in written expression, and give the uses of the period, the comma, the semicolon, and the colon.

III.

Read two or three pages from a good author. Do you find many long sentences? Are any that you find entangled and confusing? What is the prevailing length of sentences? What are the characteristics, good and bad, of the short and of the long sentences used by this author? In general, what kind of subjects do you think would in their treatment most naturally require long sentences? In the treatment of what subjects would you expect to find a predominance of short sentences? Answer the last two questions in writing, giving your reasons.

IV.

Read another group of two or three pages and study the form of sentences as you did their length. Tell in writing the advantages and disadvantages of periodic and of loose structure, as *you yourself have noted them.*

STUDIES IN AMERICAN AND BRITISH LITERATURE

STUDIES IN AMERICAN AND BRITISH LITERATURE.

NARRATIVE PROSE (*Continued*).

The drama is a form of literary art designed for the direct representation of human actions and characters, through their impersonation by actors before an audience. It may be classified as a form of the narrative, since through acts and speech it tells a story. A drama is divided into parts, called acts. There are usually five acts, of which the first contains the introduction; the second, the rising action; the third, the climax; the fourth, the falling action; and the fifth, the catastrophe, or *denouement*. Each act is divided into scenes, the events of which occur at one time and one place. Dramas may be written in prose or poetry or a combination of prose and poetry. The most artistic form is the blank verse. Lyrics are often introduced, and in them both rhyme and metre are varied at the pleasure of the author. There are two distinct classes of modern drama, tragedy and comedy. The essential distinction lies in the fact that a tragedy has a sad or terrible ending, while a comedy ends happily.

Up to the present time America has produced more great actors than playwrights; still, there are a number of our dramatists who have done really excellent work. Of dramas written in verse, George H. Boker's *Francesca da Rimini* is the best; of prose comedies, Denman Thompson's *Old Homestead* holds first place. American authors and actors of the nineteenth century have made very

skillful and artistic dramatizations of some of our novels and stories; as of Mrs. Stowe's *Uncle Tom's Cabin* and Lew Wallace's *Ben Hur*, but, best of all, Joseph Jefferson's dramatization of Irving's *Rip Van Winkle*.

Note to the Student.—A drama will be studied in *Book VI*, p. 221.

Biography treats of the lives of individuals. The mode of treatment varies according to the purpose of the author; that is, some biographers merely narrate the leading incidents of a man's life in their historical sequence, without attempting to portray his character or to analyze the motives back of his deeds, while others make an elaborate analysis of a man's character and touch only incidentally upon his history. Biography forms a very important department of literature. Some one has said that the history of the race is in the history of what men have thought and felt and done. Thus, in the biographies of a nation's statesmen, we have the political history of the nation, and in the biographies of its men of letters we have the history of literature. Washington Irving's *Life of Washington* is the best American biography.

Belonging to this department of literature is the autobiography; that is, the life of a person written by himself.

A STUDY OF BENJAMIN FRANKLIN'S AUTOBIOGRAPHY.

Note to the Student.—Study Franklin's *Autobiography* according to the outline for mastery of thought, which forms the last paragraph in the article *Reading for Information, Instruction Book IX*, p. 113. The following facts will also be found helpful to you in your study:

Benjamin Franklin's *Autobiography* is not only the best example of this kind of narrative in the literature of

America, but the best in the English language. The style is simple, clear and forcible. There is not a word wasted; nor is there a word wanting to make the author's meaning perfectly clear. Franklin did not intend the *Autobiography* for publication, but wrote it for his son. This may partly account for the artlessness of the narrative, which is one of its chief charms. The incidents of his life are interesting in themselves, but we are not so much impressed by these as by the author's personality, which is diffused throughout the whole. We feel his vigor, his originality, his shrewdness, his practical ability and his humorous appreciation of human weaknesses. It is evident that his purpose was to teach, but his style is never didactic enough to be tiresome.

BIOGRAPHICAL SKETCH OF FRANKLIN.

Benjamin Franklin (1706-1790) was born in Boston, Massachusetts. He was the son of a poor candle-maker. After two years' schooling and two more in his father's shop, where he read what few books he could get hold of, he was bound apprentice at the age of twelve to his brother James, a printer. By the time he was fifteen he was a regular contributor to his brother's paper, *The New England Courant*, modelling his style after that of Addison. He was clear-headed, independent, fond of a good time and possessed of an inordinate curiosity. His independence of spirit often got him into trouble with his brother and, finally, when he was about seventeen, after a quarrel of an unusually serious nature, he ran away to Philadelphia. Here he landed tired, hungry and friendless, with only about a dollar to his name. But having health, youth, industrious habits and a shrewd eye for business, he soon found work at his trade. After a few months he attracted the attention of the governor, Sir William Keith, who made him certain promises which induced him to go to London. In a short time he returned to Philadelphia and in 1729 established the *Pennsylvania Gazette*; from that time his influence and reputation grew rapidly. In 1732, he began to issue *Poor Richard's Almanac*, a periodical filled with

pithy proverbial sayings and useful information. Ten years later, his political life began.

By the time he was forty-two, he had founded the University of Pennsylvania, acquired a comfortable fortune, sold his printing business and become interested in the study of electricity. By his public spirit, energy and attention to details he had become a force in the country. Politics, science and diplomacy occupied the rest of his career. His discoveries in electricity are still the foundation of modern knowledge in that subject; he invented the lightning rod and the stove; was the foremost writer of his day; and at length, when the American revolution broke out, was sent by his country as ambassador to France, where he conducted the most delicate negotiations with remarkable skill and tact and was honored by Europeans as no other American has ever been. He was a signer of the Declaration of Independence, the Treaty of Alliance with France, the Treaty of Peace with England and the Constitution. On his return to America, his country welcomed him with great celebrations as "The Friend of Man" and "The Father of Independence." He lived about five years longer, loved and honored and serving his country until the last.

By many people Franklin is considered the greatest man America has produced. At all events, it is safe to say that he was great in more ways than any other American before or since his time. His pen was seldom idle, but writing with him was usually only the means to an end, as the many demands upon his time and energy left him little opportunity to devote himself to literature for its own sake. His chief claim to literary distinction rests upon his *Autobiography*, which tells the story of his life up to the year 1757.

History is, in its ordinary sense, a narrative of events in the order of time. But the tendency of modern history is philosophical rather than merely narrative; that is, the historian is no longer a mere reporter of transactions, but must be prepared to analyze character and to weigh events. But modern, as well as ancient, historians have become famous not only for the record of facts and the philosophic treatment of causes and results, but also for the vigor and polish of their style. During the nineteenth century, America has had a group of eminent his-

torians, distinguished both for the breadth and accuracy of their investigations and for the literary merit of their writings.

A STUDY OF HISTORY.

Note to the Student.—It is hoped that you will read through one of the histories of Parkman, Prescott, Motley or Fiske. But if you find it impossible to do this, read at least one chapter from one of these works, preferably from Parkman's *La Salle, or the Discovery of the Great West.* In your study, follow the outline for mastery of thought, on p. 113 in the article on *Reading for Information, Instruction Book IX.* Consider also the following questions:

(1) Does the author employ the narrative or philosophical method?

(2) Does the value of his history depend mainly upon the facts recorded or upon the literary merit of the work?

(3) Can you mention a writer of fiction who has treated of the same subjects in a novel or poem? Is the history you have read as interesting as a novel? Explain your answer fully.

SKETCH OF THE AMERICAN HISTORIANS.

George Bancroft (1800-1891) was a Massachusetts man, and, like most American historians, a graduate of Harvard. He studied also in the universities of Germany and traveled extensively in Europe. He was always active in public affairs and occupied important positions under our government, both at home and abroad. His first volume of the *History of the United States* was published in 1834 and the sixth and last not until fifty years later. The periods he chose were the colonial and revolutionary.

The style of his writing is clear, direct and precise, his chief aim being to present facts. His method is a well-balanced combination of the philosophic and narrative styles. He discerns in a given, existing condition the germ of coming events and states in a cold, impartial way the reasons for all that happens. While his histories are interesting, they do not absorb the attention as do those of Parkman, Prescott and Motley, nor is his analysis of motives and causes so attractive as that of John Fiske.

Francis Parkman (1823-1893) was born in Boston, and like Emerson, Lowell and Holmes, was the son of a Massachusetts clergyman and a graduate of Harvard. When a sophomore in college, Parkman formed the purpose of writing the story of the long struggle between the French and the English for North America. He devoted his whole life to the accomplishment of this purpose and lived just long enough to see it achieved.

The general title which he finally gave to his history was *France and England in North America.* This is made up of a series of seven historical narratives: *The Pioneers of France in the New World; The Jesuits in North America in the Seventeenth Century; La Salle, or the Discovery of the Great West; The Old Regime in Canada; Count Frontenac and New France under Louis XIV; A Half Century of Conflict,* and *Montcalm and Wolfe.*

The story of his life is one of remarkable determination and unremitting labor. When he was about twenty, he took a long journey to the Pacific coast to help fit himself for the task before him. The exposure incident to this trip made him a life-long invalid and so nearly blind that he had to dictate all he composed. But these great obstacles did not discourage him in his purpose. His inherited means relieved him from the necessity of writing for money and enabled him to travel and collect all the materials he needed.

Parkman's method was thoroughly reliable. He first mastered the facts, then set them forth in the most interesting and picturesque manner possible. Vivid description is the most characteristic feature of his work. La Salle, Montcalm, Wolfe and the Indians he was so fond of portraying seem truly alive in his pages, and in his picturesque description of nature he stands unsurpassed.

William H. Prescott (1796-1859) was the chronicler of the Spanish conquest in America and of the same period in Spain. His first history was the *Reign of Ferdinand and Isabella;* this was followed by the *Conquest of Mexico* and the *Conquest of Peru.* He had begun a *History of Philip the Second,* but did not live to complete it. He has a racy style which resembles Parkman's somewhat, but he is less discriminating in his choice of facts. Parkman impresses one with the truthfulness of his narratives, while Prescott often leaves his readers wondering whether the brilliancy of the picture is not due to too high coloring.

John Lothrop Motley (1814-1877) was another Massachusetts man and Harvard graduate. He studied also for several years in German universities, where he formed a warm personal friendship

with Prince Bismarck. He was at different times minister to Spain and England and traveled widely over Europe, where his remarkable personal beauty and intellectual attainments made him a figure of distinction, although his reserve and haughty manner limited his circle of intimate friends.

Motley was a firm believer in free institutions and popular rights. In looking back over the past, his sympathy went out to the Dutch in their struggle against the bigotry and tyranny of Philip II and he felt called to become the historian of the Netherlands. Accordingly, he planned a series of histories which under the title of *The Eighty Years' War for Liberty* was to include *The Rise of the Dutch Republic, The United Netherlands* and *The Thirty Years' War,* but he did not live to complete the last of the series. Motley's histories are the result of the most painstaking original research. His vigorous style and sarcastic humor remind one of Carlyle. But the distinguishing feature of his narrative is its dramatic power, both in revealing situations and in delineating character.

John Fiske (1842-1901) has an international reputation as an authority on American history. During the earlier part of his career he was best known as the interpreter of the philosophy of Darwin and Spencer; but he became later an able original investigator of evolution. Soon after his graduation from Harvard he was made professor of American history in that university and during his lifetime held professorships and lectureships in several of the leading universities of America and England. But the last fifteen years of his life were devoted to investigations in American history. He published in all about a dozen volumes, which taken together constitute a connected history of the United States from the earliest discoveries to the establishment of federal government.

Fiske is the only one of the American historians whose works are strictly philosophical. His style is so clear, fresh and logical that his histories are valuable contributions to American literature.

EXPOSITION.

Exposition is that form of discourse in which facts or abstract ideas are discussed and conclusions are reached by a process of reasoning. In includes (*a*) the treatise, which discusses a subject fully; as, Richard Grant

White's *Words and Their Uses*; (*b*) the essay, or briefer exposition of a subject; as, Emerson's *Self-Reliance*; (*c*) the editorial article; as, the editorials in *Harper's Magazine*, from the pen of William Dean Howells.

Essays deal with all subjects and in such a variety of ways that any attempt to classify them meets with difficulty. Almost every conceivable topic is treated,—there are biographical, descriptive, argumentative and didactic essays, and essays on science, art, religion and literary criticism. Some writers have given their whole time and attention to this form of composition and the modern magazine has become their distributing agency. Much of the deepest, brightest and best of recent work has come to its readers through this medium.

A STUDY OF THE ESSAY: EMERSON'S SELF-RELIANCE.

Note to the Student.—Emerson's *Self-Reliance* has been selected as a basis for our study, and you are strongly advised to get it. It is an essay which all young persons can understand, appreciate and profit by. But if you cannot obtain this, study similarly some other essay of Emerson's, Lowell's or Holmes'; or Washington Irving's *Westminster Abbey;* or, perhaps, one of W. D. Howell's or Charles Dudley Warner's editorials. Read carefully the article on *Reading for Information, Instruction Book IX*, p. 113.

(1) Sum up in one sentence the main thought of Emerson's Essay on *Self-Reliance*. Then make an outline containing the chief ideas which are combined to bring out this central thought. Is the essay logical in its arrangement of ideas? Is there unity of thought throughout? Are there any digressions? If so, do they distract the reader's attention from the prominent line of reasoning?

(2) Make a list of the figures of speech in this essay. What figure does the author use most frequently? Which

do you consider the most effective figure in the whole essay? Are there many scriptural allusions? Are there references to mythology and history?

(3) Are there any passages to which you take exception? If so, do you object to them because they are untrue or because you do not like the form in which they appear? Formulate in a few words the reasons for your objections, and then try to find what possible arguments the author could bring to sustain his position.

(4) Expand the thought of this sentence into a paragraph of ten or more lines: "What I must do is all that concerns me, not what people think."

(5) Explain in your own words what Emerson means by saying, "Traveling is a fool's Paradise."

(6) Select ten passages which please you because of their humor, beauty or profound thought, and memorize them.

BIOGRAPHICAL SKETCH OF EMERSON.

Ralph Waldo Emerson (1803-1882) was born in Boston, not far from the birthplace of Franklin. His father was a clergyman and his ancestors for five generations back had also been ministers of the gospel, and each in his day had ranked among the foremost scholars of New England.

After graduation from Harvard College, Emerson taught school for several years, then became a clergyman. But a change in his views as to religious rites and duties caused him to give up this calling, as he was too conscientious and sincere to preach what he did not believe. After resigning his charge he traveled in Europe for more than a year. In England, he met Wordsworth, Coleridge and Carlyle. With Carlyle he formed a friendship which endured till death. Upon his return to America he settled at Concord, Massachusetts, in the old-fashioned house which Hawthorne occupied, and celebrated as the "Old Manse." Here much of his best writing was done and here his friends, among whom were Hawthorne, Longfellow and Holmes, gathered about him.

In the autumn of 1833, he began lyceum-lecturing, which he

was to continue for forty-six years. Most of his lectures were published later in the form of essays. His first volume, which appeared in 1836, was called *Nature Essays.* At the time of his death in 1882, he was the author of about a dozen volumes of essays and a collection of poems. Though comparatively small in amount, the quality of this literary work had made him famous all over the world.

Emerson's life was simple, busy and studious. Those who knew him best testified that his disposition was angelic and his presence like a benediction. The powerful influence of his writings, as of his life, is by way of inspiration. Those who do not clearly see his meaning can yet feel his power. Like music, he uplifts the soul. The real subject in all his essays is the same, the power of man's own spiritual nature. Every word that he spoke or wrote was an appeal to man to live up to the highest within himself.

Emerson's poetry has the same aim and motive as his prose. He pays little regard to meter or conventional form in his verse, and in much of it the thought is obscure; but it has an originality and beauty which entitle the author to rank among the great poets. The *Concord Hymn* is one of the best and most popular of his poems, while his *Threnody,* written on the death of his idolized son, is one of the noblest elegies ever written.

Among American writers, Emerson may be considered first in profundity of thought and power of phraseology. Brander Matthews says that Franklin and Emerson typify for us the two sides of American character, Franklin standing for the real and Emerson for the ideal: "Self-reliance was at the core of the doctrine of each of them, but one urged self-help in the material world and the other in the spiritual."

EDUCATIONAL PSYCHOLOGY

CONCEPTS — THINKING.

Sense-perception gives us ideas of single concrete objects. As already stated, some impression from each sensation remains in the mind; by repeated experiences these impressions become united and form an idea of the object. This idea includes all the qualities of the object which we have perceived and retained; the more complete our observation, the more perfect the idea constructed. An idea so formed is called a concept, from *con*, together, and *capio*, to take, meaning that which is combined or taken together.

Our idea of an orange includes size, form, color, odor, taste, etc. It is not the idea of any particular orange, but of any orange, and can not contain characteristics which do not apply to all oranges. Concepts are abstract, that is, they are made up of certain combinations of qualities belonging to the object for which the concept stands. They are not, however, ideas of the objects themselves. This fact is quite difficult for many students of psychology to realize at first, since we no sooner bring a concept into consciousness than we transfer our thought from the concept to some individual of the class which the concept represents. When we think of horse, we immediately recall some particular horse and dwell upon that instead of horse in general; we consequently overlook the transition from one to the other. A little introspection of one's method of thinking will enable him to understand the relation of concepts to individual ideas.

A concept is not an image. An image contains the qualities and peculiarities of an individual object. Your concept of man is one thing; your mental image of your brother quite another, and must include many qualities which can not apply to the concept of man, such as height, features, color of hair, eyes, etc. The image is a definite picture complete in itself, while the concept is an abstract combination of qualities.

"The best mental images are so definite that a picture could be painted from them. A being might come under the class man and have a snub nose, black hair, scanty eyebrows, and no scar on his face. The presence of one of these individual peculiarities in the concept man would destroy it."— Halleck.

The concept is a class or general idea, and its formation requires the following steps:—

1. Presentation of material. This takes place through the senses, and needs to be as extensive and complete as possible. See *Instruction Book II*, page 237.

2. Comparison, in which the points of resemblance and difference between different individuals are noted.

3. Abstraction, in which we draw off and reject all qualities not common to the individuals examined.

4. Generalization, in which we group together objects having certain like qualities and form a class.

5. Naming, in which a name indicative of some leading characteristic is usually given the class; as, the name Vertebrata is applied to that large branch of the animal kingdom whose leading feature is a backbone.

The child forms his concepts from his daily observations, and gradually corrects and enlarges them as his experience is extended. These first concepts are very

crude and narrow. Had a child's observation of horses been confined to those of one color, as white, this color would necessarily enter into his concept of horse. When he saw a black horse he would have to correct his concept. What the child does from the beginning adults are doing all through life. Of course, a concept may be and often is based on a single observation. Such a concept contains only the most striking characteristics of the idea. Our concepts are begun by spontaneous action, but they need to be perfected by volition, which means simply continual observation and research.

The perfection of concepts includes two processes; purifying, and enriching. By the first is meant rejecting those qualities which are not applicable to all objects of the class to which the concept applies. By enriching is meant the extension of certain qualities to individuals to which they were not supposed to belong. We should not infer that a concept which has but few qualities is lacking in richness. The broader the application which we can make of any quality or relation, the more meaning it has for us. Gravitation meant more to Newton than to other men of his time because he was able to apply it to the moon in its orbit as well as to the fall of an apple. The formation of concepts which include great classes is the supreme act of the intellect.

Besides the concepts which we form of classes of objects there are others of what are known as abstract ideas, such as bravery, virtue, piety, etc. These can neither be seen, felt, nor tasted. Concepts of such ideas are based largely upon early training and environment. Abstract ideas vary greatly in different nations, and even among individuals of the same community. The concepts

of piety entertained respectively by the Christian, the Mohammedan, and the Hindoo would not agree; yet each contains the same basal idea, man's relation to a supreme being. Many illustrations of this variation can be found in every community. The different concepts of dominant abstract ideas have been the cause of some of the world's greatest conflicts.

The formation of concepts constitutes the first step in thinking; the formation of judgment constitutes the second. Judgment results from comparison, and is the affirmation of likeness or unlikeness, agreement or disagreement, between the objects compared.

"The process of judgment is always a choice between two, and only two, alternatives at any given time. The boy who is pondering over a captured bat must come to the conclusion that the bat either is, or is not, a bird." —Halleck.

"Isolated facts," says some one, "are of no more service than unspun wool." Judgment links our concepts together, and enables us to see things in their relations. Every judgment contains a subject and predicate, and a connecting term called the copula. The expression of a judgment forms a complete sentence. Since the sentence is the expression of a complete thought, we can readily see the relation of judgment to language.

Some judgments are much more easily formed than others. In the simple proposition "Grass is green," the two ideas are vividly in consciousness, since both are presented in the object, and the conclusion is easily drawn. In the comparison of an object with a concept only, it is more difficult to reach the conclusion, as the concept is less

vividly in consciousness than the object presented. It is more difficult to decide whether or not wheat is a grass than to decide that grass is green, as in making the comparison we must hold the concept grass in general, and not any variety of grass, in consciousness.

Judgments and concepts are sometimes formed simultaneously. In such case both are probably spontaneous, as in the formation of a concept by a child from a single perception. He sees a tree, and gets something of an idea of it. If he should not see another for some time, he would probably say it was a tree, too. The concept was formed unconsciously and was ready for use when needed.

The relation of judgments to concepts can be better understood by looking at what may be termed class concepts and species concepts. If a child's observation of violets has been confined to the ordinary blue violet, and he chances to find a yellow violet, his judgment is "This violet is yellow." The judgment does not go so far as to enable him to form the concept yellow violet; the examination of several specimens will be necessary to enable him to do this. Still, the judgment which refers to the characteristic of color only is a preliminary step toward the formation of the concept yellow violet, which is a species concept. Study your method of thinking and see whether most of your species concepts are formed in this way or not.

Formal reasoning constitutes the third step in thinking. Some judgments are so difficult to form that assistance is necessary. There is no apparent connection between the objects or ideas compared, and they need to be connected by the use of an object or idea whose

relation to each is obvious. This third idea is known as the middle term. Reasoning, then, is a more formal method of comparison in which the middle term is used, and in which judgments are compared. Take the simplest illustration possible. The child is asked whether or not Calcutta is in the British Empire. The two ideas are so far apart that he is unable to discover their relation, but he introduces a new idea, India, whose relation to each is known.

India is a part of the British Empire.

Calcutta is in India.

Therefore Calcutta is in the British Empire.

Such a form of reasoning is called the syllogism. It consists of three parts known respectively as the major premise, the minor premise, and the conclusion. In the above illustration the major premise is "India is a part of the British Empire;" the minor premise, "Calcutta is in India," and the conclusion, "Calcutta is in the British Empire." We must carefully note here that while three ideas are used in determining the relation, only *two* are used at a time. The attempt to use the three together is the rock upon which most pupils stumble in their reasoning in arithmetic and grammar. In this simple form is found the secret of all reasoning. Erroneous conclusions result, not so much from wrong processes of thought, as from faulty observation and incorrect concepts, which lead to wrong conclusions. At least one premise of the syllogism must be a class or general idea. Unless we understand this idea thoroughly, our conclusion is liable to be faulty. All general ideas are originally obtained through observation and experience. When obtained in this way they are usually understood.

PEDAGOGICAL APPLICATIONS.

1. There is a vital connection between sensation, sense-perceptions, and concepts. A careful review of the subject as far as studied will reveal a series of unbroken steps in the child's mental development. His success in this phase of his progress depends upon the use he has made of the phases previously studied.

2. Concepts are at first formed spontaneously and unconsciously, but they are incomplete. It is the part of the teacher so to direct the child's attention that he will voluntarily and consciously perfect his concepts. Interest in the subject studied is an important factor in securing this end.

3. The child should form clear and correct concepts early in life. The time soon comes when the ideas of individual objects obtained through sense-perception will not suffice for his needs. He wants a basis of comparison in order that he may classify his ideas. This the law of mental activity has already supplied in the formation of concepts. This law the teacher should carefully heed and faithfully follow in leading the child to enlarge and correct his original ideas. At this stage of his education concrete illustrations are the only safe means to the desired end. This does not mean simply the use of material objects, as in nature study, but also the story and the fable for establishing correct moral concepts.

The teacher's success in getting her pupils to form clear concepts will be quite in proportion to her ability to use right concrete illustrations. Concrete illustrations are frequently faulty, either from being too complex or from placing too great stress on minor details.

4. One should always be able to change his concepts into the images of the individuals for which the concept stands, when occasion requires. In general, persons who talk flippantly in abstract terms are unable to image their concepts. A lady who landed on the dock at a fashionable watering place remarked that she was glad to be on *terra cotta* once more. The schoolboy finds that 1,500 pounds of coal at $6.25 per ton cost $46.90. We are inclined to laugh at the victim of the first mistake and frown upon the victim of the second. Each is laboring under the same difficulty, inability to image the concept used.

Concepts can never be changed into images unless they are formed from observation, and are clear and accurate. Much of the difficulty in arithmetic, grammar, and geography arises from the inability of the pupils to image their concepts. The great advantage of certain systems of number teaching that have recently come into use, lies in their ability to give the pupils clear concepts of number through the right sort of concrete illustrations. It is unwise to lead young children to form concepts of abstract ideas which can not be presented by concrete illustration.

Of all persons, the teacher should be able to change his concepts into images. Examine your concepts, and see whether or no you are using any that you are unable to image. This is a good test of their clearness.

5. Concepts which are contradictory or in conflict arrest each other, hence the presentation of conflicting ideas should be avoided in teaching young children.

6. Thinking is discovering relations. This leads to classifying and adjusting our concepts. (See *Appercep-*

tion, *Instruction Book II*, page 234.) The teacher should lead her pupils to be continually on the hunt for relations. Those who are able to discover new relations become the inventors, discoverers, and general benefactors of the race.

7. There is but one thought process, and its purpose is the formation of concepts. We usually denominate the three acts in this process comparison, judgment, and conception. Comparison is really the act out of which the others grow, and all the myriad forms of thought can be reduced to the simple process of comparing two ideas and judging them to agree or disagree; upon that judgment a concept is either built or modified. The teacher who will master this truth and comprehend its full meaning, will be prepared to materially assist her pupils in becoming good thinkers.

8. Children begin to think when they begin to form concepts. The teacher who realizes this will be influenced by it in all her teaching. It will cause her to so present subjects as to enable pupils to form their own concepts instead of taking them from another.

9. Ability to think is the basis of all mental development and progress. By thinking, man has discovered means to overcome the obstacles of nature and reach a high state of civilization. The development and culture of memory, imagination, and other mental powers depend largely upon the ability to think. The wise teacher will do all that is possible to lead her pupils to acquire this power.

The thinking man is the man of progress, provided he thinks along broad and liberal lines. If he is to think in this way when he reaches mature life, he must be taught

to do so during his early years. Men whose thoughts were confined in narrow channels during their school life think in ruts, and make little or no progress. Their influence in a community is neither large nor valuable. The greatest value of a liberal education is, not in its immediate bearing upon the business or profession of the individual, but in its influence upon his life as a man. Only such an education can keep most people out of ruts.

Culture of the thinking faculty is a strong stimulus to the strengthening of the moral character. People become selfish and inconsiderate because they do not think. Such people are often the cause of a great deal of trouble. The person who is accustomed to think is liable to consider his relations to others. The power of thought is also prone to lay hold on the great moral laws that regulate conduct and keep them constantly in consciousness. Most thoughtful persons usually have a good character.

"Those who have not been early trained to see all sides of a question are apt to be extremely narrow, and undesirable to live with. Whenever one finds himself blaming other persons, he ought immediately to recall his own acts for comparison, and see if none of them is in a like manner blameworthy. By discovering the relation of identity in this way, the thinking and moral faculties will receive some of their very best training."

— Halleck's *Psychology and Psychic Culture.*

STUDIES.

I.

Prove these facts from your own experience:

1. Will is a universal phase of activity.

2. In its broadest aspect will is indefinite and purposeless; in its narrow aspect it is definite and purposive.

3. Will develops from the broad to the narrow aspect.

II.

1. Impulse leads to desire and this to deliberative action.

2. Deliberative action leads to choice, which is the supreme act of the will.

3. All ideas contain a motor element. This may or may not, of itself, lead to external action.

III.

1. Choice consists of selecting or accepting one of two or more conflicting desires. It is made with the end in view, and when adopted becomes motive.

2. We are impelled to action in the realization of our choices by the end to be attained; and not by the means of attaining it.

IV.

1. The inhibitory power of the will is the best evidence of its strength and culture.

2. Will is at the basis of habit and its proper culture is the great essential of good character.

3. Note the gradual, almost imperceptible development of will from impulse.

4. What use can you make of this with your pupils?

ELEMENTARY ECONOMICS

ELEMENTARY ECONOMICS.

CAPITAL AND LABOR.

Natural agents, capital and labor, are mutually dependent in the production of wealth. The growth of society has led to the organization of industries and the division of labor on highly specialized plans. One of the great industrial problems which has never been satisfactorily settled is that pertaining to the just apportionment of the product between the owner of capital and the possessor of labor, or the capitalist and the laborer. From the viewpoint of true economy there can be no antagonism between these classes. Each is dependent upon the other and each is entitled to its share of the product.

The capitalist is entitled to interest on his investment, and in addition such profits as will pay for the wear on his factory and for managing the business. The laborer is entitled to compensation for his time and skill.

The Wage System. The laborer's share of production was early rated in money value, and as industries became more thoroughly organized the paying of wages became well nigh universal. The relations of capital and labor are so closely allied to the adjustment of wages as to make them almost identical. The wage of the laborer is affected by a number of conditions. The most important of these are:

1. *The number of wage-earners.* When there are more laborers than there are opportunities for employment, wages will be lowered by competition. Each employer buys his labor in the cheapest market, and

most laborers prefer to accept a lower wage than not to earn anything. If, on the other hand, the demand for labor is greater than the supply, wages will rise through competition of employers. The employe sells his labor in the highest market. Prosperity in business tends to raise wages.

2. *The laborer's standard of life.* The standard of life varies with individuals and with nations. Public sentiment also has much to do with it. In the United States and some of the British colonies this standard is higher than in any other countries, consequently workmen in these countries receive higher wages than workmen engaged in the same occupations in other parts of the world.

It is true economy for the laborer to maintain the highest possible standard of life. The higher the standard, the more wants there are to be supplied, and consequently the greater demand for production. The history of industry proves, without exception, that the poorest paid labor is the dearest labor. The products of the United States, England and her best colonies have invaded the markets of the world, to the displacement of similar products from countries where labor is much cheaper. The poorly paid laborer is under-fed, poorly housed and in every way unable to compete with the workman whose standard of living is such as to command good wages.

3. *The strength and skill of the laborer.* Equity demands that the laborer be paid according to his ability to produce. If A and B are bricklayers and A can lay twice as many bricks in a day as B, he should receive twice the pay, provided each does his work equally well.

If, however, B has the skill which will enable him to do the most difficult part of the work, and that without supervision, while A can only lay bricks for a common wall and that under supervision, B's services may be worth more than A's. (See *Intelligence of the Laborer, Instruction Book II*, page 247.)

4. *The nature and permanency of the occupation.* The time and money that a person spends in learning an occupation are his capital and must be considered in determining his wages. The teacher who must spend several years and a large sum of money in preparing for her vocation would naturally be entitled to higher wages than the operative in a factory whose occupation requires little or no preparation. In general, the wages of tradesmen are higher than those of ordinary laborers.

Some occupations are much more dangerous than others and on this account pay higher wages. Trainmen on railways and employes in iron and steel mills are exposed to greater danger than carpenters or tinsmiths. You can think of several other classes to which this principle will apply.

The rate of wages in those occupations which give permanent employment is lower than in those in which employment is not permanent. The average teacher is employed about eight months in the year, while a good stenographer is employed the entire year. Provided each is required to expend an equal amount of time and money in preparation for her work, the stenographer can afford to work for less than the teacher, for it is not probable that during the four months in which the teacher is out of school she can find profitable employment at some other occupation. For the same reason laborers in lum-

ber camps and harvest fields obtain higher wages than farm hands who work by the year.

Occupations which are disagreeable or unhealthful command higher wages than those which are agreeable and healthful. Scavengers receive high wages because their work is disagreeable. Workers in lead and mercury receive high wages because their occupations are so unhealthful that they can be followed only a few years.

Were no outside influences brought to bear on the above causes there would be little difficulty between employer and employe in adjusting wages. However, various influences affecting these principles have been introduced into organized industries; the most important of these are:

1. *Corporations.* The modern tendency of capitalists engaged in the same line of production to combine in such manner as to control the manufacture, output and price of that commodity enables them by mutual agreement to fix a scale of wages for all workmen in their employ. Since it is for the interest of the employer to reduce the cost of production as much as possible, the tendency of these corporations is to lower the rate of wages.

2. *Employment of women and children.* As already stated, economists agree that the employment of women and children is against the best interests of the laboring classes. In the factory system, this leads to the employment of children at the earliest age which the law will allow. The wages of these children, at first a mere pittance, never reach the standard of wages commanded by first-class, intelligent workmen. The employment of children lowers the standard of life, and in England and

most of the United States strenuous laws have been passed regulating such employment. The employment of women lowers the rate of wages, because of the general trend of public opinion, which is that a woman is not entitled to the same wages as a man for performing the same work. However, this opinion has been greatly modified in the United States since 1870. While this sentiment is manifestly unjust, it still exerts an important influence on the question of wages.

3. *The introduction of machinery.* The introduction of machinery tends to lower wages because by the use of machines greater production is secured with fewer laborers. This creates a surplus of laborers in certain occupations. The invention of the power-loom is a good illustration of this. For a time many weavers were thrown out of work, and it was difficult for some to find employment at any price. The effect of machinery is, however, temporary, and has never been serious in the United States, because the American workman readily adjusts himself to new conditions.

Labor Organizations. Labor organizations date from the guilds of the Middle Ages. These guilds were organizations of masters and workmen engaged in the same occupation. Their objects were the mutual benefit of the members and the regulation of production. The organization of capital naturally led to the organization of labor. Modern organizations are divided into two classes—Knights of Labor and Trades Unions. The purpose of these organizations is the betterment of the conditions of their members by raising the standard of wages, reducing the hours of labor and assisting the sick and unfortunate, especially those out of employment.

Originally each labor organization included only members of a single craft, and most trades unions still adhere to this plan, being made up of skilled artisans. The Knights of Labor departed from this plan and have formed organizations of skilled and unskilled employes, regardless of trade. The labor unions have secured a similar end by affiliating the different organizations under the American Federation of Labor.

The benefits secured by labor organizations are:

1. *Higher wages.* Organized labor can secure better terms than unorganized labor when bargaining with capital. A invests $500,000 and employs 500 men. A represents all the capital while a single workman represents only one five-hundredth of the labor. The workman cannot treat with A on equal terms. But let the 500 workman combine, agree upon terms on which they will contract with A, and present these terms through their representative, and labor and capital meet on equal terms.

2. *Shorter days.* Formerly twelve or fourteen hours constituted a day's work, and even children were compelled to work for that length of time. Through the efforts of labor organizations these hours have been shortened to ten, and in some trades to eight, with a half holiday on Saturday.

3. *Intellectual and moral improvement.* All of these organizations have their meetings where the freest discussion is given to measures that pertain to their welfare. These discussions make the members thoughtful and also cause them to study industrial and social conditions. Many gatherings of a social nature are also held, in which both sexes mingle. These gatherings tend to restrain vicious tendencies and raise the moral and social stand-

ard of the members. Most of the officers and leaders in these organizations are temperance men, and by their influence and advice promote temperance among the members.

4. *Financial aid.* All labor organizations have a fund for the purpose of assisting the sick or aged, and those out of employment. Without doubt the accumulation and distribution of these funds have prevented much suffering. It is but fair to state, however, that the greater part of these funds is used to support the families of workmen who go on strike.

Without doubt labor organizations have been and are still a great benefit to wage-earners, but like all other organizations, they are subject to the frailities of human nature. The present opposition to labor unions is based on the following charges, all of which have been substantiated to a greater or less degree:

1. *They are based on strife.* It is claimed that the primary object of these organizations is to prepare their members for industrial war; such strife inconveniences the general public and affects industry unfavorably.

2. *The members are misled.* Peaceable and well-contented workmen are often misguided by agitators, who present false issues, which ultimately lead to strikes or lockouts.

3. *They are too conservative.* Many labor organizations cling to old methods and object to such changes as the general progress of the times calls for.

4. *Lack of flexibility.* Like all other large bodies, it is difficult for labor unions to adapt themselves to the constant changes caused by the march of events. Union men object to working with non-union men and they

demand that the poor workman be paid the same wages as the good; this works an injustice to many of their members.

Wages and the Cost of Labor. The difference between wages and the cost of labor should be distinctly marked. In considering wages as high or low, we treat them from the viewpoint of the laborer. In considering the cost of labor as high or low, we treat it from the viewpoint of the employer. Wages are high or low according to their *purchasing power*. If A in Chicago receives $1,000 a year, and B in New York receives $1,200, and living expenses in New York are one and a half times greater than in Chicago, A is receiving the higher wages, for he can purchase as much for $1,000 as B can for $1,500. The cost of labor is high or low according to the *returns received by the employer*. If A receives $3 a day and can perform twice the labor of B, who receives $2 a day, the cost of B's labor is higher than A's. In general, the labor which receives the highest wages is the cheapest. When employers reduce their force of employes, those receiving the lowest wages are usually the ones discharged first.

The broadest and best view of the relation of capital and labor is that which on the part of the capitalist gives to the laborer the highest possible standard of living, thereby increasing his opportunities, wants and power of consumption; and which on the part of the laborer grants to the capitalist every possible advantage to increase the rate and reduce the cost of production.